VARIABLES INFLUENCING STIMULUS OVERSELECTIVITY

IN NORMALLY DEVELOPING CHILDREN

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A Thesis

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Master of Science

Auburn, Alabama
December 16, 2005

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VITA

Kimberley Ann (Hays) Smith, daughter of Emit Calvin Hays Jr. and Carol (Meade) Hays, was born August 29, 1975, in Cullman, Alabama. She graduated from J.B Pennington High School in 1993. She attended the University of Montevallo and graduated in 1997 with a Bachelor of Science degree in Psychology. After working several years as a behavior analyst specializing in treatment of autism spectrum disorders and developmental disabilities, she entered Graduate School at Auburn University. She married Charles (Chad) M. Smith, son of Manuel and Rosemary (Mead) Smith on July 17, 1999.

THESIS ABSTRACT

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Master of Science, December 16, 2005
(B.S. University of Montevallo, 1997)

92 typed pages

Directed by James M. Johnston

Stimulus overselectivity is a type of responding observed in children and adults with autism spectrum disorders and mental retardation. It involves responding that is controlled by a small, often irrelevant portion of a total stimulus that results in other stimulus components failing to exert control over responding. Although this phenomenon has been examined frequently in individuals with autism spectrum disorders and mental retardation, few studies are available examining overselective responding in normally developing children and adults. Evidence that is available suggests that young normally developing children respond to few components of a complex stimulus. The present experiment was designed to identify variables influencing overselective responding in preschoolers and more specifically, what type of stimulus presentation might result in overselective responding. Participants, ages 3.11, 4.2 and 4.6, were presented a delayed matching to sample task displayed on a computer touch screen. The matching task was presented as a game to the children in groups of 10 trials. Stimuli appeared on the screen and the children were told to find the one that matches the first picture. Matching tasks involving size, shape, number of stimuli and configuration of stimuli within a stimulus complex were presented. Participants showed decreases in correctly matching the dimension of size when stimuli were complex and of high number. Additionally, results from the configuration condition showed that when responses to the top left shape in the configuration were required, correct responding was 50% or less across subjects suggesting that the stimulus dimensions of size and configuration within these conditions was not exerting stimulus control over participants responding. This observation of overselective responding illustrates the effect that stimulus features may have on matching responses. The results also make apparent the implications of stimulus arrangement on correct responding and the issues this poses for teachers and trainers. In addition, there does not seem to be a distinct phenomenon in any specific sense different than stimulus control deficits. Rather, it could be argued that certain stimulus presentations tend to generate particular types of errors. Conceptual and definitional issues surrounding stimulus overselectivity should be reexamined.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my husband Chad Smith. It is because of his support, patience, and love that this task was possible. I would like to thank my parents for being excellent role models for me in all areas of my life and always being supportive and loving regardless of the circumstances.

I would like to thank Jim Johnston for his guidance and willingness to teach. He gave me a chance to further my studies in behavior analysis so that I may achieve my academic and personal goals; to him I am deeply grateful.

I would also like to acknowledge Mei Jang's assistance in programming the software for this experiment. Also, thanks to Linda Silvern for allowing data collection at Auburn Early Learning Center.

Style Manual Used

Publication Manual of the American Psychological Association, 5th edition.

Computer software used

Microsoft Word 2003

Microsoft Excel 2003

Sigma Plot 9.0

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Chapter I. INTRODUCTION

Variables Influencing Stimulus Overselectivity in Normally Developing Children

Autism and its Features

In 1943, Leo Kanner first classified a group of 11 children as having early infantile autism. The word autism means "absorption in self-centered activity and extreme withdrawal or divorce from external reality". He defined his observations as "inability to relate themselves in the ordinary way to people and situations from the beginning of life". In addition, he described these children as having "extreme autistic aloneness". He delineated six common characteristics among those children he observed.

1. Profoundly impaired social interactions including aloofness and aloneness
2. An obsessive perservation of sameness in behavior that is markedly rigid, repetitive, lacking the usual play behavior of most children, and overall, lacking in creative or imaginative dimensions.
3. Impaired language and social communication, including language that is absent (mutism) deficient and, if present at all, is characteristically not aimed at communication. Two frequent verbal behaviors are echolalia (insistent repetition of words that may continue well beyond the normal age of about 3

years) and pronoun reversal, in which the “I” and “you” forms are not used correctly.

4. A strong fascination for objects that are often handled with considerable fine motor coordination
5. Exceptional memory feats may be performed by some of these children, such as repeating verbatim whole television commercials or song lyrics.
6. Autism is evident early in life and is typically diagnosed by 2.6 to 5 years (Kanner, 1943, p. 220).

Autism, also referred to as autistic disorder, is defined as a severely incapacitating developmental disorder with neurological origins involving the child’s cognitive functioning, language, social skill development, emotional life, and motor performance, occurring during the first three years of life and continuing throughout the lifespan (Autism Society of America website, 2002; Graziano, 2002). Autism is just one diagnosis on the spectrum of pervasive developmental disorders; no one child displays the exact behavioral characteristics as another child diagnosed with autism. The behaviors associated with autism can include any combination and range from mild to severe. Autism spectrum disorders (ASD) include autistic disorder, Rett’s disorder, Childhood Disintegrative disorder, pervasive developmental disorder-not otherwise specified, and Asperger’s disorder (DSM-IV-TR, 2001).

Prevalence and Incidence of Autism

Autism is currently the most frequently diagnosed of the pervasive developmental disorders and has been located in all ethnic, racial, and social groups. An exact estimate of cases of autism spectrum disorders is not agreed upon, but estimates range from 1-in-166 cases, to 1-in-1, 000 cases diagnosed in the U.S. every year (NICHD, 2002). However, males are three-to-four times more likely to be affected by autism than girls are (Wing, 1997).

Etiology of Autism

Soon after autism was recognized as a disorder, speculation began as to what could cause children with autism to fail to respond to their environment in the ways normal children do. One of the first proposals attempting to explain this was made by Goldfarb (1964). He likened autism to childhood schizophrenia and proposed that the behavior of children with autism is due to attentional deficiencies. Bruno Bettelheim, a psychoanalytic professor at the University of Chicago, believed children with autism had been raised in an under stimulating environment during the first few years life when language and motor skills were developing (Bettelheim, 1967). Lovaas and his colleagues reviewed these theoretical explanations of autism made in the 1960's in his 1971 article. None of the early theories persisted over time as valid explanations for autism nor were they widely accepted by researchers or clinicians.

More recently, theories have shifted to a different approach compared to those proposed by Bettelheim and Goldfarb. The focus on environmental teratogens has increased and is thought to contribute to the development of autism, although no particular exposure is consistently implicated. Increased occurrence of minor malformations involving posterior rotation of the ears in children with autism has been documented. The observation of physical indicators of autism may point to the introduction of teratogens during particular times of prenatal development (Rodier, Bryson & Welch, 1997). Possible prenatal and perinatal environmental events that could contribute to the development of autism include: rubella, herpes, encephalitis, maternal bleeding during mid-to late pregnancy, drugs taken during pregnancy, and Rh incompatibility. It is important to note that autism is observed throughout many different social classes, nationalities, and cultures and rules out the possibility that it is has social or cultural origins (Graziano, 2002).

Genotypic factors play an important role in the development of autism. Hereditary, genetic, and chromosomal factors are implied by the findings in twin research. While same-sex dizygotic twins have a concordance rate of 5 to 10 percent, monozygotic or identical twins have a concordance rate of 65 to 90 percent. Siblings of people with autism have a three to eight percent greater chance of having autism. Furthermore, the recessive gene metabolic disorder, phenylketonuria, or PKU, and Fragile X syndrome, a chromosomal irregularity, is present in some cases of autism (Graziano, 2002). Fragile X is an X-linked disorder thereby affecting more boys than girls. This disorder is characterized by retardation, hyperactivity, short attention span, speech irregularities, poor eye contact as well as physical characteristics such as hyperextensible joints (double jointedness), large or prominent ears, and in males, large testicles (Fragile X website, Hagerman). The concurrent presence of Fragile X and autism leads researchers to suggest it is the most common biomedical cause of autism (Graziano, 2002).

Examination of the environmental influences and possible genetic predispositions has led many researchers to suggest a biological model of autism, that is, autism as a biologically determined behavior disorder (Graziano, 2002). Piven, Arndt, Bailey, Havercamp, Andreasen, and Palmer's (1995) research revealed larger than normal brain size in 22 males with autism due to a larger amount of brain tissue and larger lateral ventricles. Another brain disorder related with autism is epilepsy. Thirty-five to forty-five percent of autism cases also experience epileptic seizures (Graziano, 2002). This correlational evidence combined with the evidence compiled across genetic and environmental influences provides a starting point from which to begin the investigation into the origins of autism. Until this research is complete, autism will continue to be diagnosed based on behavioral characteristics.

Diagnostic Criteria and Behavioral Characteristics

When Leo Kanner first distinguished the classification of autism in 1943, he commented on one of the eleven children he observed as follows:

> When spoken to, he went on with what he was doing as if nothing had been said. Yet, one never had the feeling that he was willingly disobedient or contrary. He was obviously so remote that the remarks did not reach him. (Kanner, 1943, p. 217)

Often this unresponsiveness to verbal stimuli is the first behavioral deficit parents of children with autism recognize. According to the Diagnostic and Statistical Manual 4th ed, TR, (DSM-IV-TR) to meet the criteria for diagnosis, a child must exhibit a total of six or more items from groups 1, 2, and, 3 with at least two items from 1, and 1 item each from 2 and 3:

A. 1. Qualitative impairment in social interaction, as manifested by at least two of the following:

a. marked impairment in the use of multiple nonverbal behaviors such as eye-to- eye gaze, facial expression, body postures, and gestures to regulate social interaction

b. failure to develop peer relationships appropriate to developmental level

c. a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)

d. lack of social or emotional reciprocity

2. Qualitative impairments in communication as manifested by at least one of the following:

a. delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)

b. in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others

c. stereotyped and repetitive use of language or idiosyncratic language

d. lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level

3. Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:

a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

b. apparently inflexible adherence to specific, nonfunctional routines or rituals

c. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

d. persistent preoccupation with parts of objects

B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: 1. social interaction, 2. language as used in social communication, or (3) symbolic or imaginative play.

C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder (DSM-IV-TR, 2001).

An overarching characterization observed in many children with autism is the way they respond to complex environmental stimuli regardless which class of behavior is involved.

Phenomenon of Stimulus Overselectivity

Stimulus overselectivity observed in autism.

A key underlying feature in the diagnosis of autism is the phenomena referred to as stimulus overselectivity or restricted stimulus control. Defined as focusing on a small, often irrelevant portion of a total stimulus (Graziano, 2002), stimulus overselectivity seems to affect the child with autism's overall responding. The label "restricted stimulus control" results from animal studies demonstrating the phenomena (Gray, 1976). Stimulus overselectivity has been shown to affect functioning in a child with autism in many different ways. For example, by focusing on or "overselecting" a particular feature of a stimulus, such as the color of an object, the child may have considerable difficulty learning about other features of the stimulus such as its shape. Another example might be the child focusing on only one word in a sentence. After testing to determine that the child can receptively identify a pencil and a desk, as well as the instruction "Bring me" you ask him or her to "Bring me a pencil from your desk." In the previous instruction, the child might only respond to the instruction "bring me"; instead of bringing you the pencil as you asked, the child might simply bring you something else from another place in the room, and never bring the pencil to you. Although the skill of using receptive language is considerably different from the visual task given in the first example, the result may possibly be the same underlying mechanism. However, the exact mechanism underlying overselective responding is still in question after more than thirty years of research.

Over the past few decades, many investigations searched for reasons underlying this atypical responding in children with autism and additionally in persons with mental retardation. These research efforts have resulted in two major lines of study: 1. Multiple presentation of stimuli (including visual, auditory and tactile), visual cue discriminations, auditory cue discriminations, and 2. Investigations correlating stimulus overselectivity, IQ and mental/chronological age (Lovaas, Koegel, & Schreiberman 1979).

Multiple presentation of stimuli to children with autism, normal children and mentally retarded children in the laboratory of Ivar Lovaas at UCLA resulted in an often cited series of studies. Lovaas, Schreibman, Koegel, and Rehm (1971) published the seminal study investigating simultaneous presentation of visual, auditory, and tactile stimuli. During this experiment, bar pressing was reinforced for three different subjects when they responded to the simultaneous presentation of a red floodlight (visual stimulus), white noise (auditory stimulus) and a puff of air being forced into a blood pressure cuff secured around the left calf of the child (tactile stimulus). Once this performance was established, each stimulus modality was presented separately to determine which stimulus had acquired control over responding. The results showed that children with autism primarily responded to only one of the stimuli, the mentally retarded children responded variably, and the group of normally developing children responded to all three stimuli when presented separately. It was also found that if a particular stimulus did not gain stimulus control properties or, in other words, if a particular stimulus did not come to control the child's response during the simultaneous presentation phase, it could gain control over responding if it was trained separately later. All children exhibited orienting responses to the three stimuli separately, yet the children with autism only responded to one of the components during the testing phase. There was no evidence of a particular stimulus modality exerting control in any of the groups. In discussion of his finding, Lovaas et al., stated that the data showed that when autistic children are presented with multiple stimulus inputs, their behavior often comes under the control of a range of input that is too restricted (1971). Lovaas consequently labeled his observations as stimulus overselectivity because the subjects overselected a portion of the stimuli available. To clarify, this label does not imply that the children scan their environment and select a portion of a relevant cue; they quite possibly may select an irrelevant or minor feature of a cue while not responding to relevant features of the cue (Lovaas et al., 1971).

After the initial study, it was determined that the child with autism may have been "flooded" or "overloaded" with stimulation. To simplify and ameliorate this possible confound, Lovaas and Schreibman (1971) conducted a study using only two stimuli: auditory and visual. Actually, the same subjects, procedure, and stimuli were used as in the first study (a red floodlight and white noise). However, there were two groups observed in this study, children with autism and normally developing children. The normal group showed no evidence of stimulus overselectivity, similar to findings in the previous study; however, the children with autism showed somewhat different results compared to the previous study. Four of the six children with autism showed overselective responding; that is, only one of the stimuli controlled responding. The other two children with autism showed little or no evidence of stimulus overselectivity. Although there is no definitive reason for this difference, Lovaas and Schreibman suggested that a possible reason lies in the fact that the previous study used three different stimuli, while this study used two different stimuli. This finding led to the conclusion that overselectivity may be more clearly observed with a larger quantity of stimuli (Lovaas, Koegel & Schreibman, 1979).

The findings from the Lovaas et al. (1979) study led to further questions surrounding the reasons for overselective responding in the autism population. One possibility is that children with autism have great difficulty responding to separate components of a complex stimulus. Another proposal was that children with autism are "super-efficient"; that is, their selection behavior is reinforced in the presence of an isolated portion of a discriminative stimulus resulting in only a portion of the entire stimulus complex acquiring control over responding.

In 1977, Koegel and Schreibman conducted another study to answer the questions formulated based on results of the Lovaas et al. (1979) study. The design of the experiment was a reversal of the previous two investigations. The stimuli (auditory and visual) were first presented individually and the children received reinforcement for responding to them separately. Then stimuli were presented in three different ways: visual only, auditory only, or visual/auditory simultaneous. Only responses to the simultaneously presented stimuli were reinforced, whereas in previous studies responses to a particular individual stimulus were reinforced. The results of this study demonstrated that the children with autism continued to respond to only one of the stimulus components for hundreds of trials, even though they received no reinforcement for doing so. Also, responding to the other (also nonreinforced) stimulus extinguished rapidly (Koegel & Schreibman, 1977). This finding led Koegel and Schreibman to drop the hypothesis that children with autism were "super-efficient" in their responding, but to retain the hypothesis that children with autism do have difficulty responding to stimuli with multiple components (Lovaas, Koegel, & Schreibman, 1979).

Following Lovaas, Koegel, and Schreibman's research using multiple cue presentation, the possibility arose that stimulus overselectivity was being observed among children with autism because they have difficulty responding when stimuli are presented simultaneously in more than one sensory modality (Lovaas, Koegel, & Schreibman, 1979). Reynolds, Newsome, and Lovaas (1974) developed a study to test if this hypothesis was true in the auditory modality. Two groups were used in the study: an group of eight children with autism with a mean age of eleven years, seven months, and a normally developing group of eight children, mean age six years, six months. The children were trained to press a bar when a two component auditory stimulus was presented. During the test phase, the children were presented with individual components to assess if responding was controlled by both individual components, only one of the components, or both of the components. The children with autism responded to only one of the stimuli presented separately, while the normally developing children responded to both stimuli presented separately (Reynolds, Newsome, & Lovaas, 1974). This replicates the findings observed by Lovaas, Schreibman, Koegel, and Rehm (1971) and Koegel and Schreibman (1977) using stimuli from different modalities.

In addition to the studies examining auditory performance in children with autism, the use of visual stimuli to demonstrate stimulus overselectivity has also been widely employed. Koegel and Wilham (1973) conducted a study similar to that of Reynolds et al. (1974) to test if the presentation of only visual stimuli might alleviate overselective responding. Fifteen children with autism and fifteen normally developing children were trained to respond to a complex visual stimulus made up of a card with two pictures divided by a line. The children were tested by presenting single components of the stimulus complex to determine if one component or both would control responding. As found in previous studies, the children with autism primarily responded to only one of the stimuli, although the majority of normal children responded to both. While the majority of normal children responded to both stimuli presented separately, it is important to note that three of the normal children did exhibit overselective responding (Koegel & Wilham, 1973).

The location of visual cues was proposed as a controlling factor by Anderson and Rincover (1982). Anderson and Rincover conducted their investigation using eight children with autism and eight normal children. Their goal was to demonstrate the generality of stimulus overselectivity. Two experimental phases were implemented with all children in the study. First, a pre-assessment was conducted to select children who showed evidence of overselective responding. Two-digit numbers on 15X15 cm poster board paper were the stimuli employed in the assessment and test conditions. Children were trained to respond to one number (42) and to not respond to another number (96). Reinforcement schedules were gradually thinned from continuous to VR 4 as consecutive correct responses were increased. To determine which stimulus (the 4 or the 2) was controlling responding, test trials were conducted presenting the number 41 and 82. Children that responded at chance levels (70% or less) were not included in the following phases because it was not conclusive they were exhibiting overselective responding.

Phase two consisted of an assessment of gestalt responding. (Gestalt is a concept used to refer to an object made up of many parts, yet commonly controls responding as one stimulus.) Children were trained to respond to three stimulus conditions involving circles made up of many small dots (small, medium and large), while receiving mild punishment for responding to a blank card presented simultaneously. A test or probe condition was then introduced and a circle was presented on one card and a random assortment of dots was presented on the other card. These type probe trials were presented to determine the degree of stimulus control acquired by the circle (or the gestalt) versus the components of the circle (the dots). Data collected under these two conditions was examined to discover whether children would respond to the components (dots) and their location and to assess whether stimulus overselectivity varied as a function of stimulus parameters, such as how close the dots were to each other (Anderson & Rincover, 1982).

Children with autism responded to the small and medium size circles during the probe phase, but when the condition containing the large circle and dots was presented, 6 of the 8 responded to the large randomly placed dots. This suggests that overselectivity in children with autism is not a generalized phenomenon across task conditions, but might be a function of task parameters. This study further demonstrated that the nature of stimulus variables influenced the responding of both normal and autistic children (Anderson & Rincover, 1982).

A few years later, Rincover, Feldman, and Eason (1986) conducted a study using children with autism that examined the absolute distance components were located from each other, leading them to label certain types of responding "tunnel vision". The stimulus conditions for this study varied the distance (small, medium, large) of the center cue from the other cues. Stimulus control probes were conducted for each stimulus condition to determine which cues the children were learning (Rincover et al. 1986). The results of this study revealed that the distance between the cues did make a difference in the number of stimulus features the child responded to. When the distance between cues was reduced, the number of cues controlling responding increased. However, this finding was not observed in the normal children included in the study (Rincover et al. 1986).

These studies examining children with autism help reveal some of the conditions under which stimulus overselectivity is observed. The "tunnel vision hypothesis" continues to be referred to as one of the possible factors of influencing visual stimulus overselectivity in those with autism. However, stimulus overselectivity has not only been investigated in children with an autism diagnosis. Studies demonstrating stimulus overselectivity in individuals diagnosed with mental retardation has also been an active line of research.

Stimulus Overselectivity observed in mental retardation.

In their 1971 study, Lovaas, Schreibman, Koegel, and Rehm found that children with mental retardation typically responded to only two of the three test stimuli, even though all three were presented simultaneously in the training sessions. Wilhelm and Lovaas (1976) used subjects divided into three groups: severe MR, moderate MR, and non-retarded. Subjects were trained on a visual discrimination task to respond to stimuli cards with two pictures and were tested to see if they would respond to only one of the pictures. Wilhelm and Lovaas found that the lower the IQ of the subject, fewer cues were responded to.

Litrownik, McInnis Wetzel-Pritchard, and Filipelli (1978) conducted a study examining stimulus overselectivity using a matching to sample task. Seven Down's syndrome children, seven autistic, and seven normal children were taught a matching to sample task to further examine the attentional differences between children with autism and MR. Results showed that the children with Down's syndrome matched significantly fewer pictures that the autistic or normal children.

Bailey (1981) examined stimulus overselectivity in mildly retarded and learning-disabled public school children. The children were trained on a three-component visual discrimination task and then tested on individual elements to determine which was controlling responding. Nine of the mentally retarded children and eight of the learning disabled students showed some overselective responding. The majority of the retarded children exhibited stimulus overselectivity by responding to only one of three components of the discrimination task, although the majority of the learning disabled children responded to the discrimination task by only responding to two of the three components (Bailey, 1981).

These studies demonstrating the phenomena of stimulus overselectivity in mental retarded children suggests that stimulus overselectivity is not observed only in children with autism. Furthermore, it is not a phenomenon only observed in children. Stromer, McIlvane, Dube, and Mackay (1993) used teenagers and adults with mental retardation to test if they exhibited stimulus overselectivity under conditions previously used with non-human subjects such as pigeons and monkeys (D'Amato & Salmon, 1984; Riley, 1984; Riley & Roitblat, 1978). They used a delayed matching-to-sample procedure with complex sample and comparison stimuli. In this case, stimuli included two or more features such as color and form. Stimuli were either one or two simultaneously displayed pictures. All subjects responded with high accuracy when the stimuli only contained one feature, however when the contingency was changed, requiring the subjects to discriminate between two features of the stimuli, accuracy dropped considerably.

Huguenin and Touchette (1980) used color and tilted lines to examine stimulus overselectivity in mentally retarded adult men. After training on the task, the two features were combined and referred to as "conflict-compound" stimuli. Reinforcement history was reversed for one element of the compound. After responding to the compound stimulus was 95% accurate, control by each element was measured. The unchanged element of the compound stimulus (regardless of type) consistently exerted control correlating with the reinforcement contingencies associated with that compound. This study not only exhibited stimulus overselectivity in adults, but the role reinforcement plays in overselective responding.

The studies summarized thus far demonstrating stimulus overselectivity in autistic and mentally retarded children and adults, has led to speculation that stimulus overselectivity is a function of developmental level or mental age (Hale & Morgan, 1973; Koegel & Wilhelm, 1973; Lovaas et al., 1971; Ross, 1976; Wilhelm & Lovaas, 1976). Smeets et al. (1985) discusses this possibility, noting that stimulus overselectivity is observed in both normal and handicapped children of low mental age and suggesting that normal children become nonoverselective as they grow older and the degree of stimulus overselectivity covaries with the degree of handicap. Whatever the cause of overselectivity, it has been demonstrated in individuals with mental retardation.

Stimulus Overselectivity observed in normal children

A few researchers have tested normal children for evidence of stimulus overselectivity. Eimas (1969) was one of the first, and he conducted a study of elementary school age children in kindergarten, second, and fourth grade children. They were trained on a single, two-choice discrimination with either two, three or four relevant and redundant visual cues. Pertinent to this review, the study examined how many cues are employed in problem solution, and the effect of developmental level on the use of multiple cues.

The stimuli used were color-form patterns. The original presentation consisted of two relevant cues, for example a green triangle. The three component cues were color, form, and size (large green triangle). The four-cue condition contained the above components, but in addition had a 1/16-inch border outlining the pattern that contained both slanted and alternating dashes of black and white, vertical dashes of black and white, or a solid black line. All 270 elementary students were tested individually and then received twenty-five trials per day until they correctly discriminated twenty out of twenty-five trials or until 100 trials had been administered. Nine students from kindergarten, eight from second grade and two from fourth grade failed to learn the original discrimination. Furthermore, the number of errors made by the kindergarten children, was greater than for the older children 15 compared to 10.5 and 7.4 for second and fourth graders. In addition, children on average responded to at least two cues and often three, but the number tended to increase with age. These findings show that younger, normal children typically use no more than two cues when completing a discrimination task.

In 1973, Hale and Morgan proposed a new method for assessing children's component selection by testing if they responded to a single feature of a multi-component stimulus. Two age groups were tested: the mean for one group was 4.6 years and the mean for the other group was 8.8 years. The stimuli used included colored shapes on black cards, white shapes on black cards, and colored cards. Two sets of five stimuli were used that differed in the color chosen to be associated with each shape as well as in the particular group they were in. The five cards were displayed with the shape facing away from the subject and with instruction to match the cue card to one of the five display cards. This procedure resulted in evidence that the younger group responded primarily to a single component (shape) during the acquisition of the discrimination.

Duarte and Baer (1997) were able to show evidence of overselective responding in a normal adult population using a facial recognition task. In the first session, all participants were shown eight pictures of male hairstyles paired with a name. Then participants viewed all the hairstyles again and were asked to respond with the correct name. This error-corrected training was conducted until participants had named each picture of hair correctly in two consecutive cycles. Then the complete faces (sudden construction) were added to the hair pictures and naming and correction were provided. In addition, a gradual construction procedure was conducted with some faces; one element at a time was added to the face after the participant had correctly named all faces in their current state and in two different orders. Probes were then conducted showing each face without its hair. Participants were asked to name each face as before but without corrections. Verbalization of how difficult the discrimination was given when the first probe trial was presented. The results showed that when a single stimulus is programmed as the only possible controlling stimulus, the addition of more potential controlling variables could result in variable amounts of overselectivity.

Another area of study conducted involves studies demonstrating stimulus overselectivity in children with autism and normal children matched by mental age/IQ (Koegel & Wilhelm, 1973; Schover & Newsome, 1976; Rincover & Ducharme, 1987; Rincover, Feldman, & Eason, 1986; Reynolds, Newsome, & Lovaas, 1974). Correlational data found within studies examining stimulus overselectivity and low mental age reveal some learner characteristics that may also be present when overselective responding is observed. It may prove helpful to the field of autism treatment to compare skill development of normal children and children with autism. This evidence begs further inquiry into this phenomena's presence in normal children. Table 1 contained within Appendix B summarizes the studies reviewed within this manuscript by listing the population and the variety of stimulus presentations used to study overselective responding.

Practical Implications

Even though instances of stimulus overselectivity are observed in normally functioning adults, the extent of stimulus overselectivity in normal children seems to lessen as they grow older, at least according to the current literature available. The challenge for trainers and teachers of children with autism is how to establish discriminated responding, and research does not often support clear training protocols. There is a protocol-training flowchart informally available that is rumored to have originated from Lovaas' intervention program, but no citation evidence can be located. In 1998, Mark Sundberg and Jim Partington published the ABLLS (Assessment of Basic Language and Learning Skills). This assessment recommends a teaching sequence for language skills that somewhat alleviates the problem of the lack of sequence for instructional goals when teaching discriminated language skills to children with autism (Sundberg & Partington, 1998). Although these resources are available, they are rarely used by those trained outside the field of behavior analysis.

If typically developing children are able to overcome overselective responding through normal developmental processes and experience, might study of their acquisition of discriminative skills lead to new procedures to reduce this problem in children with autism? Determining what factors enable normal children to reduce this type of responding may give insight into ways of addressing this problem in those with developmental disabilities.

What are the features of skill development by which a normally developing child responds correctly to discrimination tasks without responding overselectively? Stimulus overselectivity is present when simultaneous cues from different modalities are presented and when cues from the same modality are presented, as has been shown by the autism studies reviewed. However, the variables controlling stimulus overselectivity in normal children are still unclear. While stimulus overselectivity has been thoroughly studied in the autism population, the variables associated with overselective responding have not been adequately investigated in normal children. It is unknown if there are particular features or arrangements of visual stimuli that make overselective responding more or less likely to occur. The purpose of the present study was to determine what particular stimulus features lead to stimulus overselectivity in normally developing children.

Chapter II. METHOD

Participants and Procedure

Participants were selected from Auburn University Early Learning Center on the campus of Auburn University. Three preschool students (ages 3 years 11 months, 4 years 2 months, and 4 years 6 months) were selected to participate based on parental consent, the child's willingness to participate and scores on the Differential Ability Scales®. The Differential Ability Scales® (DAS) published by The Psychological Corporation was administered by a master's level psychologist who was supervised by a Ph.D. licensed psychologist.

The DAS is an individually administered battery of subtests comprised of 17 cognitive and 3 achievement subtests. It is designed to provide a measure of conceptual and reasoning abilities useful for diagnostic and placement purposes. T-scores and the GCA (Global Conceptual Ability) score contributed to the selection of children to participate in the study. Selected children's T-scores and GCA score had to be at or above age level on the following subtests:

1. Verbal subtest
2. Non-verbal subtest
3. Spatial subtest

The objective of examining these particular criteria was to exclude participants that were not at normal developmental level in the areas of language and spatial skills. This allowed the researcher to minimize the possibility that a particular type of responding was due to a developmental disability or delay. This was necessary because stimulus overselectivity is commonly observed in children with developmental disabilities; excluding those children not scoring at age level in these skill areas allowed selection of children who were developing normally.

Following the administration of the DAS, each participant was asked to name favorite toys, games, and cartoons. If the participant was selected to continue in the study, this information was used to select visual stimuli that flashed on the computer screen when the correct response was selected. The information was also used to purchase items that were kept in a closed box accessible only after completing a session. These preferred items included computer games, coloring and drawing materials, and small toys.

The experiment was conducted in the research lab of the Auburn University Early Learning Center over a nine-month period. Participants sat at a child-sized table in front of a touch screen placed over the monitor of a laptop computer. The experimenter was present in the room seated in a chair beside and slightly behind the participant's chair to prompt the participant to respond if necessary. The stimuli used in the experiment were displayed using Visual Basic® software. This software program also compiled raw data and created graphs. Additional graphs were constructed using Microsoft Excel® and Sigma Plot®.

Pilot Studies

Some features of the experiment were determined by a series of pilot studies that took place over a six month period. During these pilot studies, the experimenter presented different stimulus conditions and combinations of stimuli to determine what stimulus features might influence the way normal children responded in this procedure. Overall, fewer correct responses were observed when the stimuli presented within the matching task contained more two or more stimulus features. This led to the development of four different stimulus conditions containing matching tasks grouped by stimulus dimension.

Observations during the pilot tests also led to the development of the shape configuration condition. Some participants were only using a particular shape within a group of shapes to select a correct matching response.

Furthermore it was determined that participants had more difficulty attending to all the features of a stimulus when there were more, rather than fewer comparison stimuli presented. Coupled with the fact that teaching skills to young children occurs with multiple stimuli present, this observation resulted in the decision to present eight comparison stimuli from which to choose the correct response.

In addition, session length was determined from pilot studies. When sessions of only ten trials were tested, most students requested more trials. When sessions of thirty trials were tested, some students, especially those younger than four years, requested to end the session early. Based on these observations, twenty trials were presented each session. If the participant requested to continue after twenty trials, then ten additional trials were completed.

Reinforcer usage was also manipulated during pilot studies. Children named some of their favorite toys and cartoons following the DAS assessment session, and it was observed that pictures of these named objects and novel auditory stimuli presented after a trial did increase matching responses for most pilot participants. Based on this observation, it was determined to use preferred visual stimuli and a novel auditory stimulus as a reinforcer after each trial throughout the experiment (See Figure 1).

Figure 1. Example of visual stimulus

Design Overview

The overall design of the experiment is summarized in Table 1. Details not included in the table are provided in text. Each participant followed the sequence of phases listed in Table 1. However, within phases two and three, blocks of 10 trials for each stimulus condition were randomly presented across participants to eliminate the possibility that patterns of responding were due to a sequence effect.

The stimulus arrangement on the screen for all phases is diagramed in Figure 2. The location of stimuli on the screen was counterbalanced across trials to ensure that particular types of stimuli and location of correct responses were not presented in the same location from trial to trial within a block of 10 trials. When the eight comparison stimuli appeared on the screen after presentation of each sample stimulus, there was up to a 0.25 probability that the correct response could be chosen. (To show eight comparison stimuli, some stimuli were presented on the screen more than one time.) The trial sequence used throughout the experiment is diagramed in Figure 3.

Location of the correct response on the computer screen throughout the experiment was counterbalanced so that the location of the correct response was not presented in any pattern or more or less frequently in some locations. However, data were examined to determine if a particular location was selected more frequently for each participant. Following completion of the experiment, correct and incorrect responses were tallied for each location on the screen to reveal if participants exhibited position preference.

Table 1

Summary of all phases

Phase	Description	Number of trials
1. Training	1. Touch screen training	5
	2. Delayed matching to sample training	10
2. Pre-experimental	Tested matching performance on all 4 stimulus conditions in isolation	10 trials per stimulus condition (40 total trials)
3. Experimental	Tested matching performance on all 4 stimulus conditions while additional stimulus features were varied across blocks of trials	10 trials per stimulus condition (180 total trials)

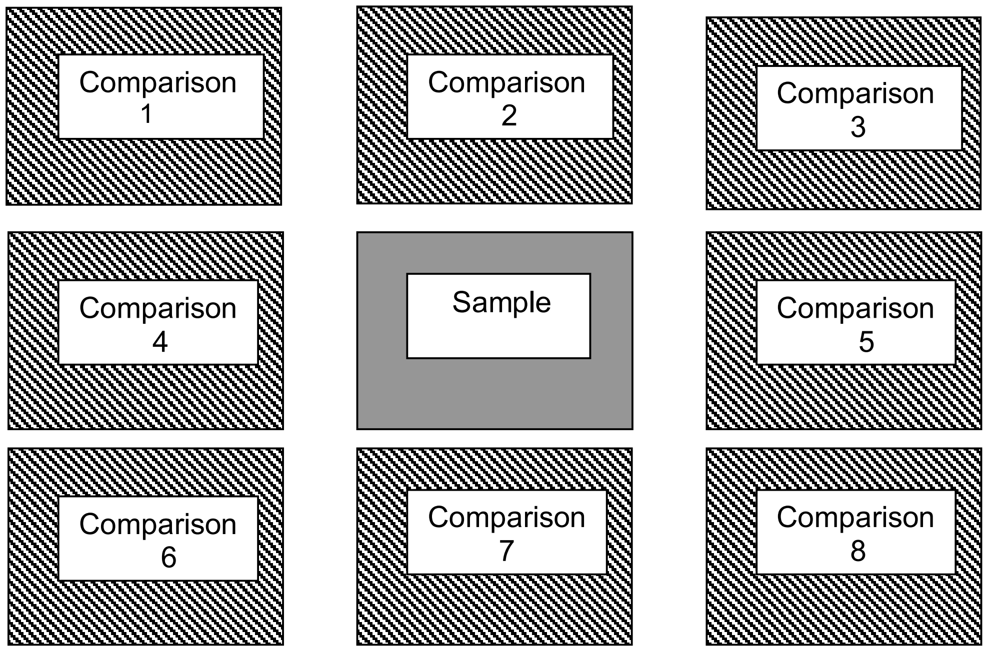
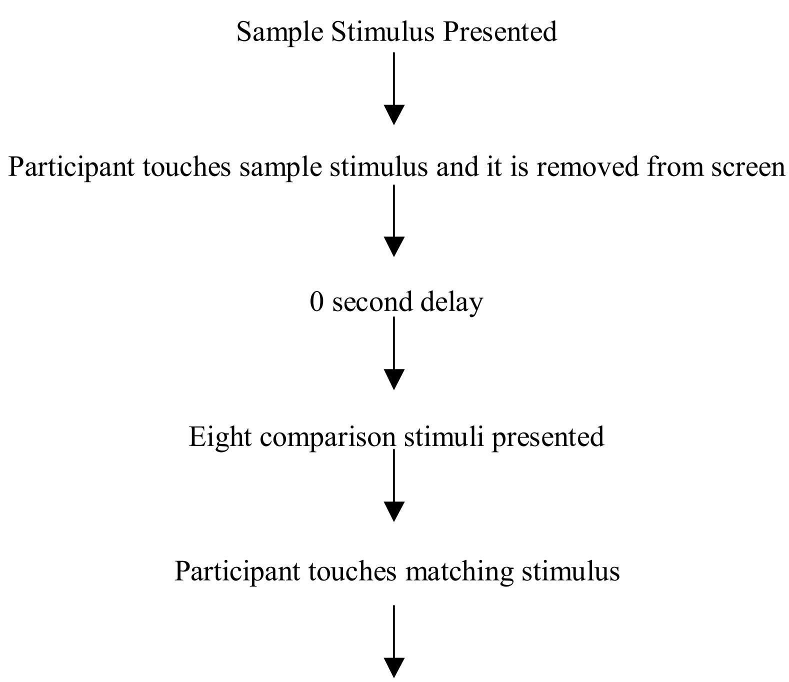


Figure 2. Diagram of stimulus presentation on touchscreen. Sample stimulus is removed after observing response, and comparison stimuli are presented after a zero second delay.



Response results in visual/auditory stimulus presentation (correct) or

3 sec. black screen (incorrect)

↓

2 second Inter-trial interval

Figure 3. Example of trial sequence for Training phase-Step 2, Pre-Experimental phase, and Experimental phase.

Training phase

Participants first engaged in training to generate performance characteristics necessary for appropriate sensitivity to the independent variable. These characteristics included the ability to consistently select a matching comparison stimulus when a sample stimulus was presented. The training phase comprised two steps: 1.Touch screen training and 2. Delayed matching to sample (MTS) training (0 s delay). During touch screen training, a single stimulus appeared on the center of the screen consisting of pictures of common objects children often encounter in their daily environment. (Figure 4) Participants were verbally prompted to touch the stimulus. If the verbal prompt was not effective, the intrusiveness of the prompts increased until the participant responded. Each response was consequated by a three second cartoon flashing on the screen and an auditory stimulus consisting of praise or a funny sound. The cartoons were selected based on information provided by the child during the initial assessment. The computer software was programmed to randomly select audio and video files throughout the experiment. When responses occurred independently five out of five consecutive trials, the next step began.

Figure 4. Example of stimuli used in the Training phase-Step 1.

During the second step of the training phase, a delayed matching-to-sample (DMTS) task was introduced. The sample stimulus was presented in the center of the screen. (This step used the same type stimuli used in the first step). When the participant touched the stimulus after the instruction, “Find the one that matches.” the sample stimulus was removed and eight comparison stimuli were presented on the screen. (Figure 5) The position of the correct match on the screen was counterbalanced across trials. If a correct response occurred, a visual/auditory stimulus was presented for three seconds. If an incorrect response occurred, a black screen appeared for three seconds. Ten consecutive correct responses allowed the participant to start the pre-experimental phase.

Sample stimulus presented

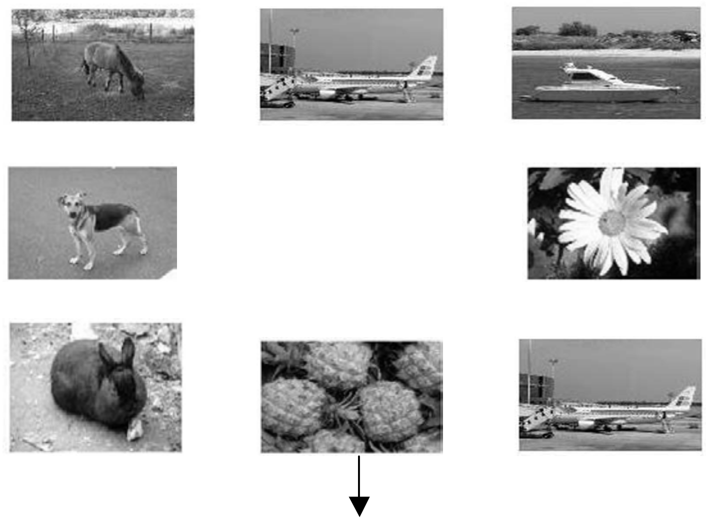
Participant touches sample stimulus and it is removed from screen.

↓

0 second delay

↓

Eight comparison stimuli presented



Response results in visual/auditory stimulus presentation (correct) or 3 s. black screen (incorrect).

2 second Inter-trial interval

Figure 5. Example of Training Phase-Step 2

Pre-experimental phase

After completion of both steps of the training phase, the participant began the pre-experimental phase during the next session. This phase provided a baseline measure of matching performance for each of four stimulus conditions (shape matching, size matching, number matching, and configuration of shape matching). This performance showed that the participant could accurately match stimuli from each condition before stimulus conditions were manipulated within the experimental phase. Before starting this phase, participants were informed that there may be more than one correct response on the screen and that just selecting one of them would be correct. The performance criteria required to progress to the next phase was 10 out of 10 consecutive, correct, matching responses.

Each participant completed 10 trials within each of the four stimulus conditions during this phase. Table 2 lists the stimuli used in each condition within the pre-experimental phase. Figure 6 shows an example of stimuli presented within this phase.

Table 2

Pre-experimental phase stimulus conditions

Stimulus Condition	Stimuli used in pre-experimental phase
Size	Small & large circles
Shape	Circle & oval
Number	1 circle & 2 circles
Configuration of shape	Grouping of 4 squares and 4 circles

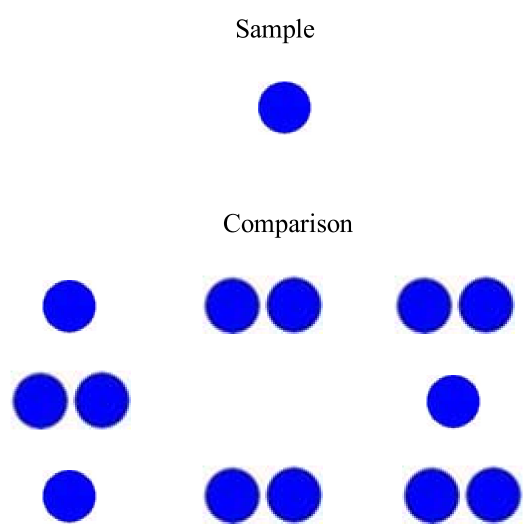


Figure 6. Example stimulus presentation within pre-experimental phase for number condition.

Experimental Phase

The same procedures used in the pre-experimental phase were used in the experimental phase except that stimulus presentations were manipulated during each condition (Table 3). Each stimulus condition (size, shape, number and configuration) contained different manipulations of stimulus presentations across blocks of 10 trials. For example, within the size condition, the participant was required to make matching responses based on the size of the sample presented, while comparison stimuli in one block of trials were complex shapes of a high number (Table 4). Within the configuration condition note that although the experimental design does not change, the stimuli manipulated are confined to the placement of certain shapes within the configuration whereas within the other conditions size, shape, and number are manipulated. The sequence of stimulus conditions presented within the experimental phase varied randomly across participants over the duration of the experiment.

Table 3

Experimental Phase Stimulus Conditions

Stimulus Condition	Variables within each condition
Size	Small
	Medium
	Large

Stimulus Condition	Variables within each condition
Shape	Simple (1-3 lines)
	Complex (4-8 lines)
Number	Low (1-4)
	High (5-10)
Configuration of shape	No color cue
	Color cue-top left
	Same shape-top left
	Different shape-top left
	Cross Condition

Table 4

Stimulus manipulations within three stimulus conditions

Size	Shape	Number
Low #/Simple	Low #/ Small	Small/Simple
Low #/Complex	Low #/ Large	Small/Complex
High #/Simple	High #/ Small	Large/Simple
High #/Complex	High#/Large	Large/Complex

The size matching condition consisted of large, medium, and small shapes or groupings of shapes. Each shape's number of pixels (size) remained constant in relation to the other stimuli presented with it as comparison stimuli. For example, if all large stimuli within a block of trials were 90 pixels, medium stimuli would be 60 pixels, and small stimuli would be 30 pixels. Blocks of 10 trials were presented for each stimulus manipulation, totaling 40 trials within the size condition.

The shape condition included shapes made up of differing numbers of lines. Two groupings based on the number of lines were presented: simple (1-3) and complex (4-10). An additional manipulation of shape was presented in the form of Chinese characters. Table 4 outlines the stimulus manipulations presented within the shape condition.

The number condition was presented as different numbers of shapes within a group. Two categories of number of shapes were used: low (1-4) and high (5-10). Table 4 outlines the stimulus manipulations presented within the number condition. See Appendix B for examples of all sample and comparison stimuli used during the experiment.

Configuration of shape was manipulated in the following ways. A "No color cue" condition consisted of four shapes in 2X2 columns, and neither shape nor color changed from trial to trial within the top left position. A "Color cue" condition consisted of four shapes in 2X2 columns, and the color of the shape placed within the top left position changed from trial to trial. A "Same shape" condition was made up of 4 shapes in 2X2 columns and one color was used for all shapes, and the shape in the upper left position of the configuration did not change across trials. A "Different shape" condition contained 4 shapes in 2X2 columns, and one color was used for all shapes while the shape in the upper left position of the configuration changed across trials. A "Cross condition" presented four shapes of the same color placed in a cross type configuration in which the left most shape changed each trial. The configuration conditions were created to determine which parts of a complex stimulus might control the correct responding (Table 3). An example of stimuli presented in the configuration condition is shown in Figure 8.

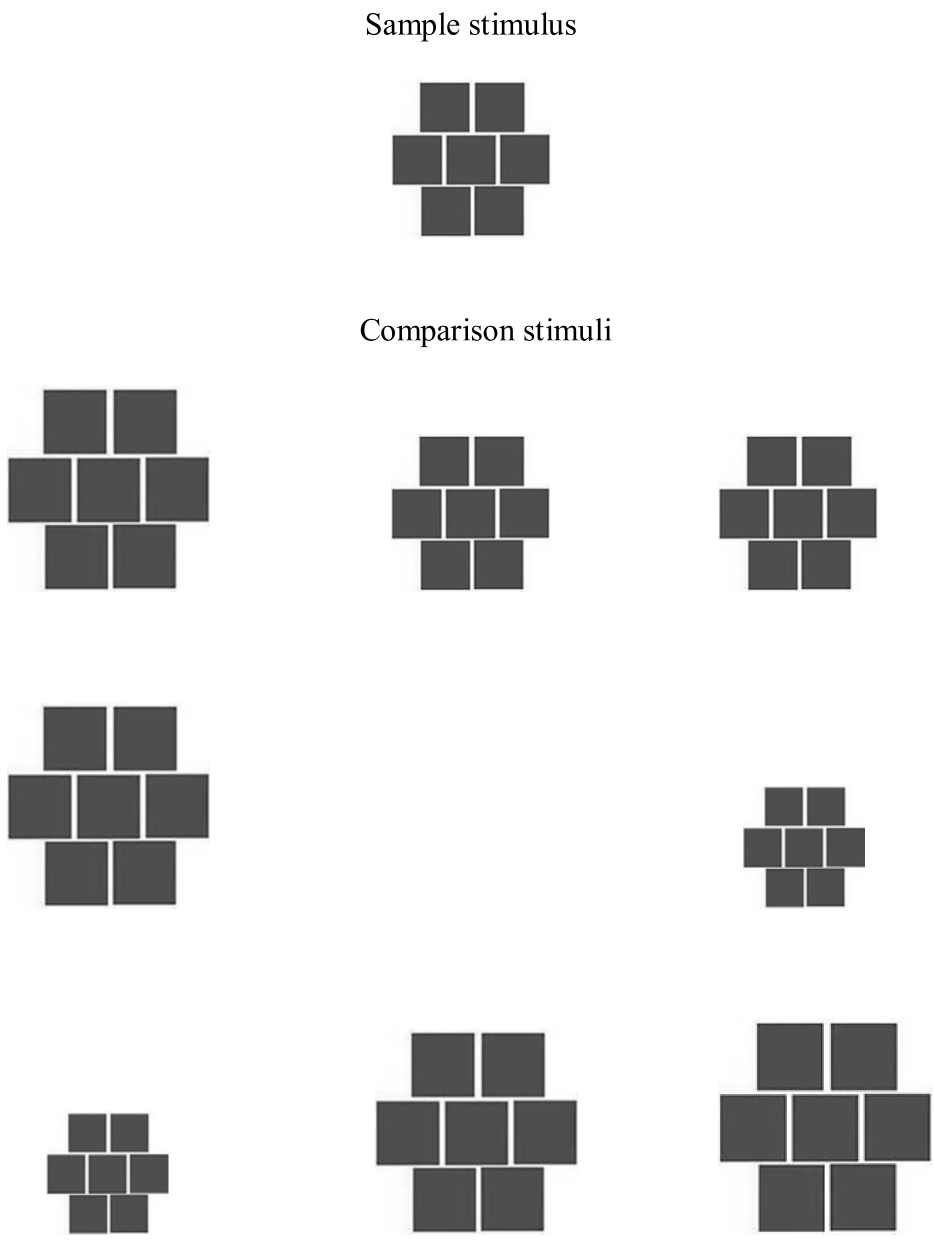


Figure 7. Example of stimuli presented in experimental phase in size condition with a high number of complex stimuli.

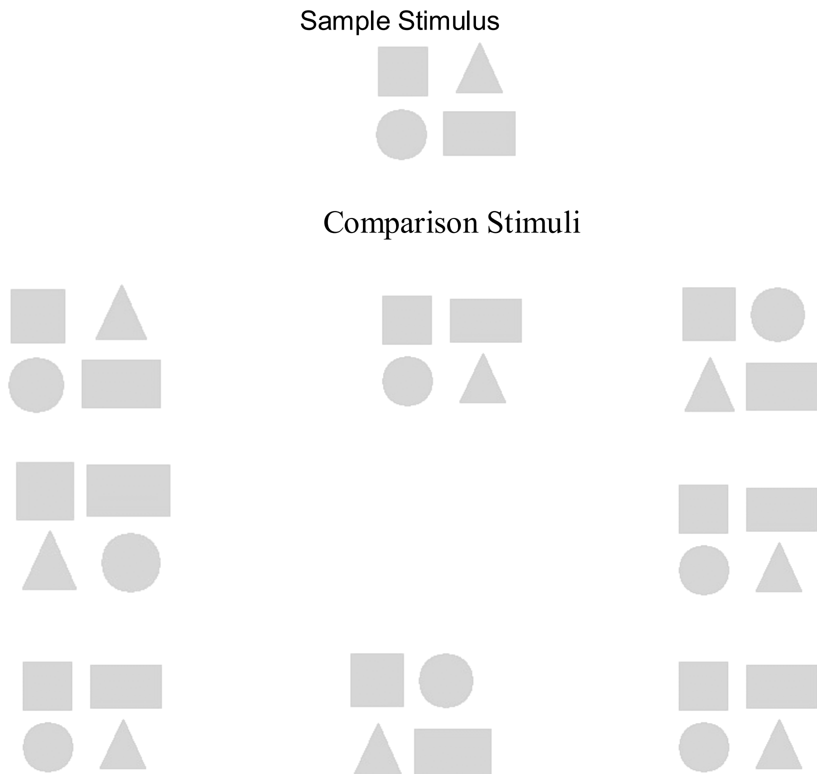


Figure 8. Example of stimuli presented in experimental phase configuration condition-same shape-top left position.

Data Analysis

Data analysis focused on determining if overselective responding occurred. This was accomplished by examining the frequency of correct responses within each stimulus manipulation under each stimulus condition. An inference of stimulus overselectivity was made when a participant's matching accuracy in the experimental phase decreased to 50% accuracy or less compared to the pre-experimental phase. If correct responses occurred within a particular stimulus condition, it was evidence that the child can respond to all dimensions of a stimulus to make a correct match. If incorrect responses occurred during a particular stimulus condition it was evidence that the child could not respond to all dimensions of the stimulus to make a correct match, therefore responding overselectively when particular stimulus dimensions are present. Stimuli selected instead of the correct response were also examined to determine if a particular feature of the stimuli was controlling responding.

Chapter III. RESULTS

Three subtests from the Differential Ability Scales® (DAS) were administered to children prior to their participation in this study. These three subtests evaluated verbal, non-verbal, and spatial skills. Each subtest reported a raw score that was transformed into an ability score. The DAS ability score is an estimate of a child's level of ability measured by the subtest. Ability scores were then converted to T-scores, which are normative scores and are defined with reference to score distributions of children of the same age in a standardization sample. Once T-scores were obtained for each subtest, the examiner summed the T-scores and found the corresponding GCA (Global Conceptual Ability) score. Table 5 shows classification of Global Conceptual Ability (GCA) scores.

T-scores and GCA scores obtained from the DAS are reported in Table 6. All participants' scores fell in the average GCA classification or higher. The DAS scoring manual recommends a child be further evaluated for mental retardation or developmental delay only if GCA scores fall in the below average category or lower. Based on these guidelines, the scores for all children participating in the present experiment were within normal age range.

Data analysis and graphical presentation

Data obtained from the training phase for each participant were obtained only as an artifact of instructing the participant to make matching responses using the touch

Table 5

Classification of GCA scores

GCA Scores	Category	Percentiles
130 and above	Very High	98-99
120-129	High	91-97
110-119	Above Average	75-90
90-109	Average	25-74
80-89	Below Average	9-24
70-79	Low	3-8
69 and below	Very Low	1-2

Table 6

Participant's T-scores and GCA scores

	Verbal T-Score	Non-verbal T-Score	Spatial T-Score	GCA
Participant 0003 (age 4.6)	80	40	49	114
Participant 0004 (age 4.2)	46	41	41	90
Participant 0011 (3.11)	57	62	58	112

screen. Analysis of these data is not included for this reason. Data collected on the accuracy of responding within pre-experimental and experimental phases are presented as number of correct matching responses when particular stimulus conditions were presented. The conditions presented included matching size, shape, number, and configuration. Within each stimulus condition, features of the stimuli presented varied across blocks of trials. For example, across the blocks where size matching was tested, the stimuli varied from small to large, simple to complex, and low number to high number.

Figures 9, 11, and 13 show the bar charts for each stimulus condition. These illustrate the effects of two stimulus features on matching responses. To isolate further the particular stimulus dimensions that affected matching responses, the second bar charts shown (Figures 10,12, and 14) illustrate the effect of one stimulus feature on matching responses. This two-part presentation of data assists in illustrating a single stimulus dimension's influence on responses without the influence of the dimension it was presented with during the experiment. It is important to note that the second set of bar charts simply re-presents the data contained in the first set of bar charts.

Size matching

The stimulus characteristics that varied when matching size were complexity of shape and number of objects. Figure 9 shows the number of correct responses when participants were matching the dimension of size. All participants showed fewer correct responses when a greater number of complex stimuli were presented. Participant 0011 also showed decreased correct responses when a fewer number of complex shapes were presented.

Figure 10 further clarifies the influence of complexity of shape on matching responses and represents the data shown in Figure 9. All participants made fewer correct responses when shapes were complex as compared to simple suggesting that overselective responding occurred more frequently when shapes were complex. In summary, correct responding decreased during the size matching condition when more, rather than less complex stimuli were presented.

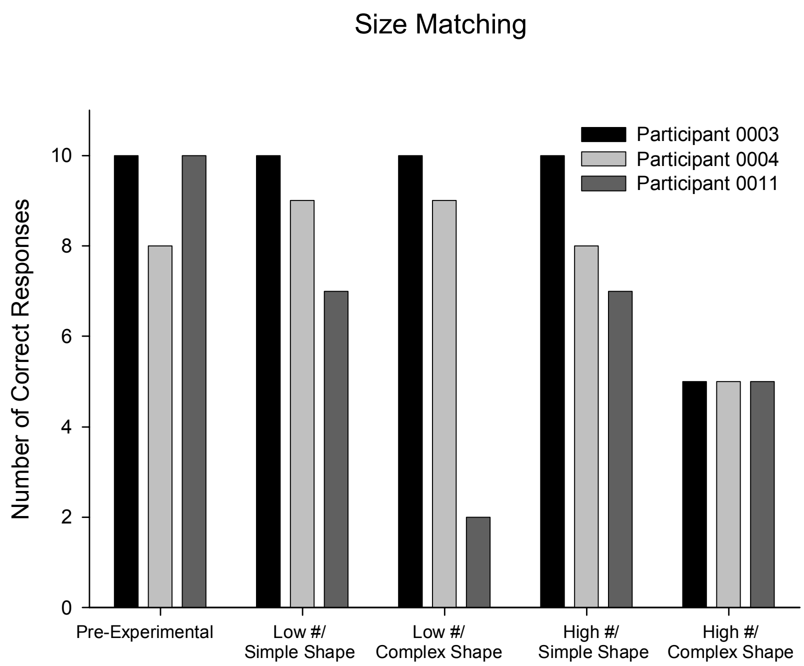


Figure 9. Number of correct size matching responses for all stimulus conditions.

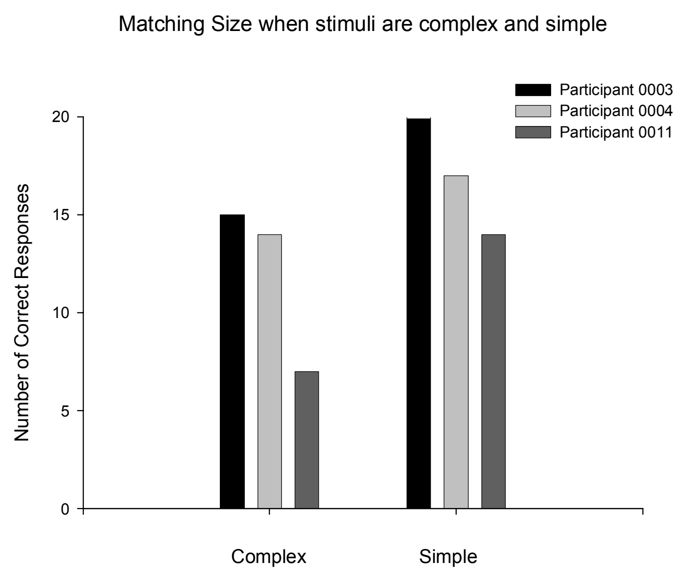


Figure 10. Number of correct size matching responses made when stimuli presented were complex or simple.

Shape matching

The stimulus features that varied while matching shape were size and number of objects. Within the shape matching condition, there was no overall decrease in correct responses observed across participants (Figure 11). However, participant 0011 showed decreased correct responses when the stimuli presented were small in size. Figure 12 represents the data showing the influence of only small and large stimuli on shape matching. Again, no overall decrease is noted for participants, with the exception of participant 0011 when small stimuli were presented (Figure 12).

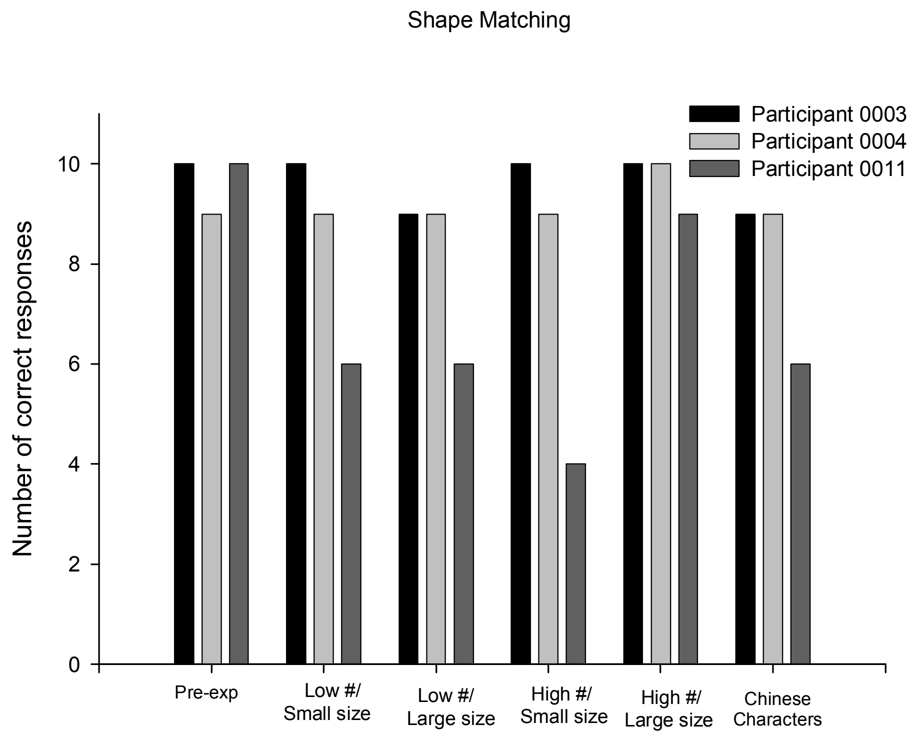


Figure 11. Number of correct shape matching responses.

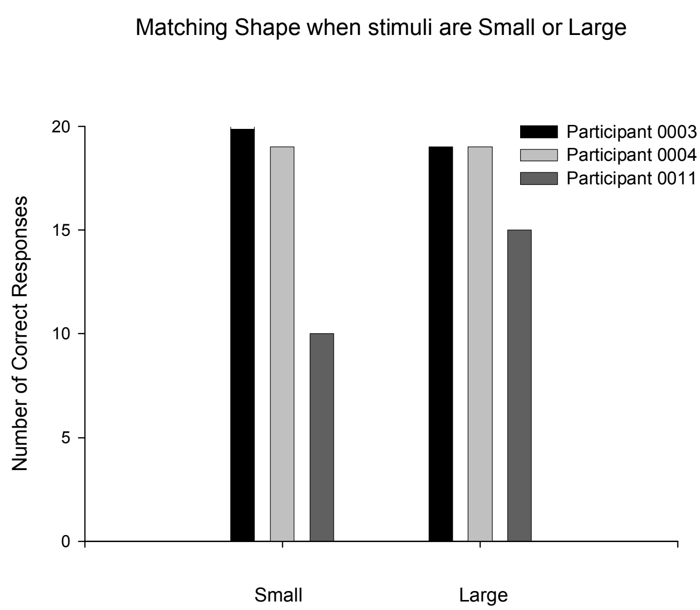


Figure 12. Number of correct shape matching responses when stimuli were small or large.

Number Matching

The stimulus characteristics that varied while matching number were complexity of shape and size. Responding observed within the number matching condition showed no overall decrease in correct responses (Figure 13). Participant 0004 however showed decreased correct responses when stimuli were large in size. Later, ten extra trials were presented to participant 0004 to rule out the possibility that an intervening variable was controlling responding. The additional trials resulted in only five of ten correct responses. As observed in shape matching results, participant 0011 showed fewer correct responses when stimuli were small in size, while the other participants did not show a decrease (Figure 14).

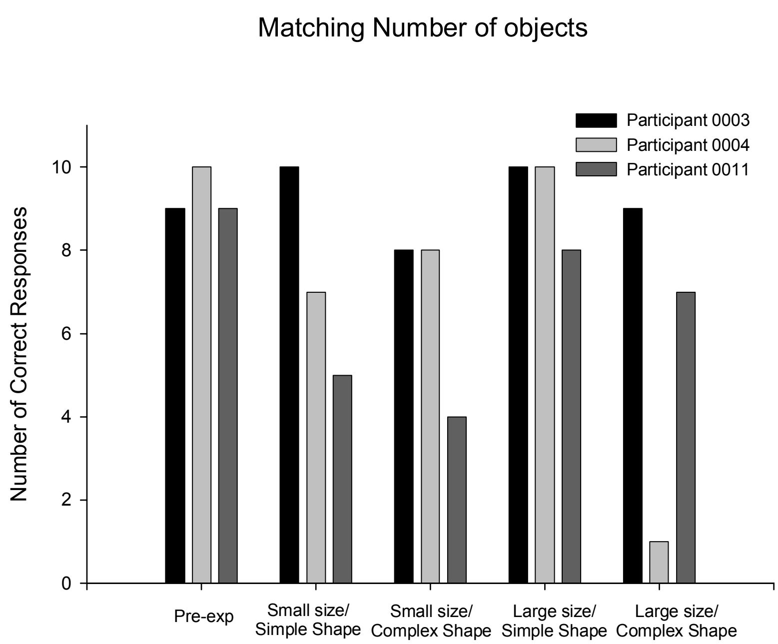


Figure 13. Number of correct “number of objects” matching responses is shown.

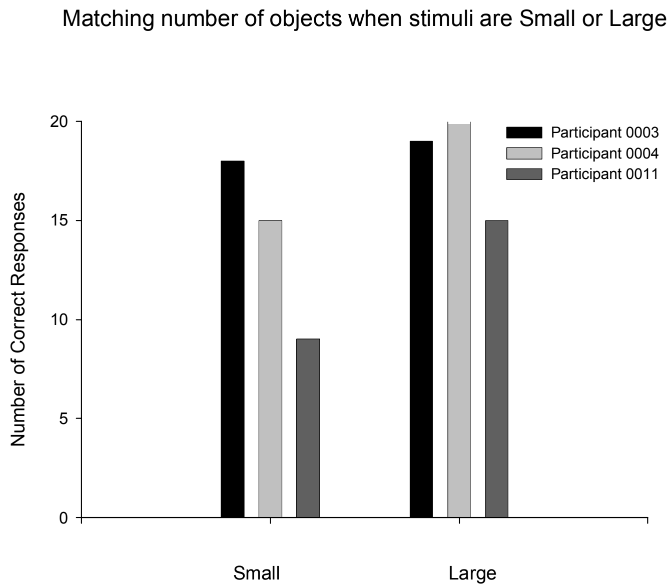


Figure 14. Number of correct number matching responses when stimuli were small or large.

Configuration matching

Within the configuration condition, the group of stimuli labeled different shape-top left, resulted in 50% or fewer accurate matching responses across participants. The stimuli presented contained four shapes in 2X2 columns, and one color was used for all shapes while the shape in the upper left position of the configuration changed across trials. Results from the configuration conditions color cue-top left and same shape-top left show some degree of decrease in accuracy across all participants when compared to pre-experimental performance (Figure 15.) The stimulus conditions presented within the configuration condition show an overall decrease in correct response selection, however only the “different shape –top left” condition resulted in fewer correct responses across all participants.

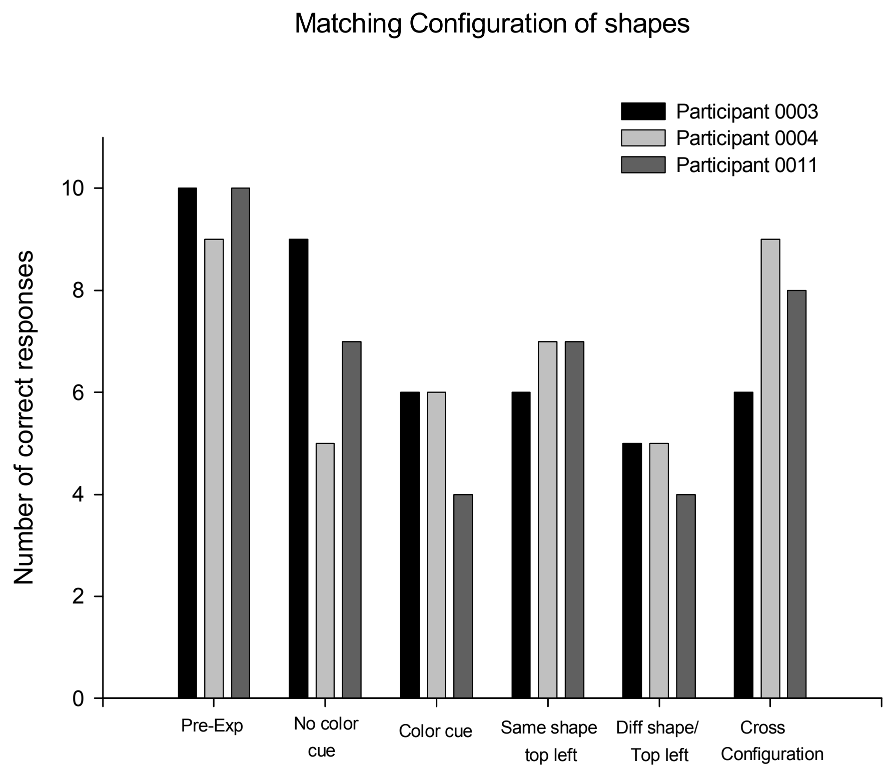


Figure 15. Number of correct matching responses when configuration of shape was manipulated.

Response Location Data

Sometimes stimulus overselectivity is observed when a particular location on the computer screen is repeatedly selected while the correct response is located in another position on the screen. Participant 0011 demonstrated a position preference throughout the experiment. As demonstrated in Table 8, participant 0011 had a high frequency of responding to location seven on the touch screen when location seven was incorrect compared to other locations on the touch screen. This table also illustrates the larger number of errors in overall responding by participant 0011. A reduction in correct responding during some stimulus conditions is similar to that of other participants, however the position preference by participant 0011 must be considered.

Table 7

Location of incorrect responses for Participant 0011

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Location 7	Location 8
12	5	0	0	9	3	26	8

Summary of Results

Overall, results observed in the size condition and in the configuration condition revealed stimulus features and combinations of stimulus features that resulted in overselective responding by these participants. Within the size condition, correct responses for all participants decreased when a greater number of complex shapes were presented. Within the configuration condition, although an overall decrease in correct responding was observed suggesting difficulty in selecting correct responses, in "Different Shape-Top Left" 50% of the responses were incorrect across participants. Despite similar performances by participants in the size and configuration conditions, no overselective responding was observed in the shape or number condition aside from individual differences.

Chapter IV. DISCUSSION

Summary of findings

Preschoolers with no detectable developmental delays were presented with delayed matching to sample (MTS) tasks composed of different stimulus dimensions: size, shape, number and configuration. All three participants showed decrements in correct responding during the size condition when there were more rather then fewer stimuli and when stimuli were more rather than less complex in shape. This suggests that typical preschoolers may have difficulty making size discriminations when there are more stimuli and when these stimuli are relatively complex. In other words, multiple features of stimuli may affect discriminated learning.

Throughout the study, incorrect responding revealed overselective responding when multi-component stimuli were presented and decreases in correct matching responses were noted when all components of the complex controlled responding. Responding in the presence of small, medium and large size stimuli revealed that when a smaller number of complex shapes were involved, overselective responding was not observed. However, when there were more stimuli presented but they were less complex in shape, no decrease in correct responses occurred. This suggests that the combination of increased number of stimuli and complexity of shape resulted in overselective responding. Failure to respond to changes in size when other stimuli features (e.g., complexity of shape and number) are present can interfere with learning.

Although the observation of overselectivity when matching size when stimuli were of high number and complex was found for all three participants, there was some evidence of a position preference for one participant (0011). Position preference is observed when responses are repeatedly made to a particular location of stimulus placement instead of to the stimulus itself. Position preferences are commonly observed in children on the autism spectrum during teaching interventions and it has been considered as overselective responding by some researchers (Glenn, Whaley, Ward & Buck, 1980). It is unclear why participant 0011 exhibited position preference throughout the experiment.

In contrast to the effects of complexity of shape together with number of stimuli when matching size, manipulation of the complexity of shapes alone did not reveal overselective responding. The data showed that all three participants had little difficulty selecting the correct matching responses, whether the shapes involved three or fewer straight lines or Chinese characters. This finding is contrary to the suggestion that stimulus overselectivity might partly be a function of the familiarity of the stimuli presented. At least in the case of the stimuli used in this experiment, this relationship was not observed.

The arrangement of stimuli in presentations defined their configuration. One configuration consisted of four shapes placed in 2X2 columns. A second configuration also consisted of four shapes, but in a "cross" arrangement. Two participants (0004 and 0011) showed the same number or more correct responses in the cross than the 2X2 configurations. In other words, when potential matches included a stimulus presented in the 2X2 configuration, they were more likely to respond incorrectly than when stimuli were placed in the cross configuration. The 2X2 arrangement places two stimuli (shapes) in the left-most positions, whereas the cross arrangement presents only one shape in the left position. A possible reason for this performance is that they may have already acquired a history of "reading" stimuli from upper left to right and then down. The cross arrangement was presented to assess this possibility.

Also within the configuration stimulus presentations, the condition that presented a different shape in the top left position on each trial resulted in all three participants obtaining five or fewer correct responses. It is not completely clear why this decrease in responding was observed, however closer examination of the responses chosen as correct show that two participants (0003 & 0011) were not using the lower left position to respond. Because they were not using the lower left position to make their selection, stimuli on the right of the configuration controlled responding, suggesting that they were scanning from top left to top right. Participant 0003 and 0011 did have pre-reading skills, while participant 0004 did not; this may be evidence that instruction in pre-reading skills may affect performance in other tasks, such as complex stimulus matching.

In contrast to Configuration condition--different shape-top left, within the condition--same shape-top left, the top left shape did not change on each trial. Correct responses were greater in the same shape-top left condition compared to the different shape-top left condition. These conditions can be examined even further by inspection of the stimuli chosen instead of the correct response. Within the same shape-top left stimulus condition, stimulus configurations that retained the same two shapes on the left side of the complex were chosen as correct matches, disregarding the shapes on the right side of the complex that were different, suggesting the tendency to respond to the left portion of the stimulus complex. This finding is somewhat surprising because it contradicts the observations found in same shape-top left regarding using stimuli on the right side of the stimulus complex. However, another possible reason for this observation could be explained in the simple fact that the number of changing stimuli within the configuration was reduced within the same shape- top left configuration. The findings within the configuration conditions illustrate additional facets of stimulus presentations that can affect the acquisition of discriminated performances.

Future research directions

Matching to sample procedures were employed in this investigation in part because they are a commonly used classroom teaching technique with preschool age children. Many learning activities in the preschool classroom involve matching objects, letters, and numbers during daily activities. The other frequently used procedure for examining stimulus overselectivity is discrimination training. This procedure involves reinforcing responses to a particular stimulus or particular features of a stimulus, then slightly altering the presentation of the stimulus and observing if the child responds discriminately to the change. Future research using discrimination training procedures should be conducted using the stimulus dimensions employed in this experiment. It may further clarify if stimuli manipulated during matching to sample tasks produce the same performance in a discrimination task. This would benefit the field by revealing that some types of stimuli may evoke overselective responding only in the context of certain types of tasks (e.g. MTS).

Specific research using the stimulus dimensions employed in this study should be conducted. Other presentations of size matching with multiple component stimuli could further illuminate what was observed in this study. Presenting a size-matching task when the shapes of the stimuli are different each trial would also shed further light onto the observations made in this study. It should be examined to determine if overselective responding could be occurring because the shape and number of stimuli presented remained the same in this experiment. The configuration of shape condition needs further inquiry as to what stimuli affect responding when location of shape is altered across trials. Also within the configuration condition, it should be tested if the number of stimuli that changes among the comparison stimuli influences responding to all features of the stimulus complex. This information could assist in understanding discrimination learning in children with developmental disabilities compared to normally developing children. Observing the exact details of how children learn to discriminate between objects and features of objects could greatly assist in bettering the technology available to teach children with developmental disabilities.

Examination of overselective responding in conjunction with particular skills a child is learning, such as reading, would provide more specific information about errors and possibly better solutions to minimize these errors. It would be helpful to determine if the same types of errors are observed when presenting stimuli in isolation than when presenting stimuli in a multiple component manner. Investigation into the effects of a gradual increase of the number of stimuli until a more complex stimulus is presented may also provide useful information to teachers.

The preschool children in this study showed overselectivity when particular matching responses were required. An area of further research should look at these same stimulus dimensions in the child's natural learning environment. Bickel, Richmond, Bell and Brown (1986) were able to clearly show the influence of contextual factors and historical factors in the occurrence of overselectivity in adults. This should also be examined in children to further determine what contextual factors may occasion overselective responding in everyday tasks commonly presented in a preschool classroom. One method of examining this would be to present tasks on a computer monitor and objects from the child's natural environment to determine if overselective responses are more likely using a particular method of presentation.

Practical Implications

This study adds to the literature on this topic by identifying particular stimulus dimensions to which children may exhibit overselective responding. The fact that participants had difficulty making size discriminations when a larger number of complex stimuli were presented offers some important suggestions for teaching children size related concepts. It may be difficult for some children to learn such concepts in the presence of other stimulus dimensions.

Another way of putting this is that teachers might unknowingly select stimulus dimensions that generate overselective responding. Awareness of the different dimensions an object contains is pertinent information for the teacher to consider. When number of objects and the shape of the objects can affect responding when learning about another stimulus dimension with normally developing children, it is imperative that teachers consider the consequences of this when teaching children with autism. Lack of attention to stimuli dimensions and arrangements of training stimuli could result in overselective responding that might not otherwise be found (Glenn, Whaley, Ward & Buck, 1980).

Much of the overselectivity literature addresses ways of modifying overselective responding. Although teachers can use various training procedures to overcome this kind of responding, another option is to modify training stimuli. One way to do this is to limit the number of stimulus dimensions within a teaching arrangement. Another strategy to consider is conducting a probe of stimulus presentations with students to isolate and observe problematic patterns of responding to particular stimuli before creating the training stimuli. Using a matching to sample presentation on a computer or creating physical materials may be an easy and efficient way of conducting the probe. Assuming that all children learn efficiently using the same teaching materials is a premature assumption that should be avoided.

An alternative analysis may include determining which features of a stimulus complex a child is more likely to attend to and adjusting instruction methods to maximize teaching opportunities instead of trying to "fix" the problematic responding. If it is commonly observed that a child tends to respond to a particular feature of an object, quite possibly the teacher could use this to their advantage rather than considering it a barrier to instruction. If it is presumed by the instructor that overselective responding is an artifact of self-stimulatory behavior, such as responding to a particular color or shape of an object, and that feature has been shown to be a reinforcer, this could possibly work to the teacher's advantage, rather than serving as a barrier.

Conceptual issues surrounding stimulus overselectivity

For those responsible for treating children with autism, stimulus overselectivity is often viewed as a major barrier to learning and a very limiting condition. The DSM-IV-TR specifies diagnostic criteria that include descriptions of overselectivity that must be observed for diagnosis:

3. restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
   a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
   b. apparently inflexible adherence to specific, nonfunctional routines or rituals
   c. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
   d. persistent preoccupation with parts of objects

This type of responding is generally discussed as a debilitating problem not only among children with autism but among those with other developmental disabilities, particularly mental retardation. However, there is accumulating evidence that it is commonly observed in many different populations of learners with varying skill levels. In other words, such findings suggest that it is a relatively common phenomenon.

The fact that this kind of responding can be observed among individuals with widely varying characteristics raises questions about the fundamental nature of what is called stimulus overselectivity or restricted stimulus control. These questions are reflected in disagreements about the definition of stimulus overselectivity. Although many researchers often site Lovaas, et al (1971) as the source of their definition of stimulus overselectivity, different investigators operationalize the concept with varying procedures and stimulus features. As a result, the research literature has as yet failed to clarify the features of a distinctive phenomenon. What the literature has made increasingly clear is that errors in bringing responding under stimulus control are easily obtained in learners who otherwise differ in significant ways, and it does not seem to be the case that these errors are not observed beyond a particular age since it is a phenomenon observed throughout adulthood (Duarte & Baer, 1997).

The phrase "stimulus overselectivity" implies that the responses of a person that exhibits it are overly controlled by a particular feature of a stimulus. This may not be the case, however. The notion of overselectivity may inappropriately imply a particular behavioral process that is not justified by experimental findings. It could be argued that certain training procedures (e.g., matching to sample) tend to generate certain patterns of errors depending on the particular nature of training stimuli. The research literature has increasingly identified some of the features of stimuli that can influence patterns of errors.

In a related study, Bickel, Stella, & Etzell, (1984) have suggested that stimulus overselectivity should not be thought of as a phenomenon, as much as it should be examined within a hierarchy of stimuli that control responding. Their analysis led them to suggest that overselective responding can be described as "the ordering of stimulus elements in a stimulus control hierarchy rather than limited stimulus control". This challenges the notion that stimulus overselectivity is "restricted stimulus control," a phrase that is often used interchangeably with stimulus overselectivity in the behavior analysis literature. In addition, the varying viewpoints and interchangeable terms for stimulus overselectivity throughout the literature present considerable difficulty to applied behavior analysts and parents of children with autism when searching for information on the topic; the variation in usage and definition often causes more confusion than assistance.

The present findings and the study by Bickel, et al. (1984) shows that the pattern of errors in matching to sample procedures that is sometimes termed as stimulus overselectivity need to be reexamined. The concept of overselectivity may not be a useful way of describing such responding. The phrase implies a particular, clinically specific tendency that is no longer supported in the literature. There does not seem to be a distinct phenomenon in any specific sense different from stimulus control deficits. Instead, a more accurate way of conceptualizing overselectivity would be in light of the stimulus control literature. More specifically, noting that particular features of training stimuli may result in certain types of errors under certain conditions.

Considering the problematic conceptual issues mentioned above, future research should continue to examine stimulus overselectivity as type of responding that all humans experience under certain stimulus conditions. Based on the results observed in these children, conceptual and definitional issues surrounding what has been referred to as stimulus overselectivity (or restricted stimulus control) should be reconsidered. In addition, these results could provide a foundation for examination of other behaviors observed in both children with developmental disabilities and in normal children. This would be valuable because to provide ethical and high quality intervention for a child with autism, their skill levels should be compared to that of a typically developing child.

In summary, the dimensions of size, and configuration of shape revealed overselective responding in normally developing children. Although the participants scored average or above average on the DAS, the ease with which stimulus conditions were altered to cause normal children to respond overselectively suggests that stimulus overselectivity is not a special condition itself. The significance of stimulus conditions outlined in this study should be considered when observing overselective responding in treatment settings. Before a consequence-based intervention is attempted, careful examination of the teaching stimuli should be considered. Additionally, stimulus overselectivity should not be presented as a phenomenon that is observed only in children with autism, but as a phenomenon that can be observed in any population given the proper stimulus conditions. Applied implications of the findings in this study can lead to improvements in selection of teaching techniques and stimuli used for training. This study can serve as a guide to the applied and experimental fields of study. Consideration of the applied and conceptual issues surrounding stimulus overselectivity warrants further consideration in the field of autism treatment.

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VI. APPENDICES

APPENDIX A

Verbal Assent to participate in

Stimulus Variables Influencing Stimulus Overselectivity
In Normal Children

Researcher: Kim H. Smith

“Would you like to come with me and play a computer game for a few minutes?”

If the child responds “**Yes**”, then the researcher will escort the child to the computer room.

Before beginning the game ask:

“You can stop playing the game anytime you want to. You just need to tell me, okay?”

“Do you have any questions before we begin?”

If the child states that “**No, I do not want to play**” or if he or she states that they do not want to continue at any point, then the researcher will ask the child to participate on a different day. If the child “**No**” or “**I’m not sure**” the researcher will also ask the child to participate on a different day.

Parent Sign-Up List for

VARIABLES INFLUENCING STIMULUS OVERSELECTIVITY
IN NORMAL CHILDREN

Please put your child's name and your name

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________
19. ____________________
20. ____________________
21. ____________________
22. ____________________
23. ____________________
24. ____________________
25. ____________________
26. ____________________
27. ____________________
28. ____________________
29. ____________________
30. ____________________
31. ____________________
32. ____________________
33. ____________________
34. ____________________
35. ____________________
36. ____________________

Scripts

(to be used during data collection sessions)

Begin Session: “You sit here in front of the computer. I’m going to start the game now. If at anytime you need to take a break or quit playing just tell me.”

Prompting during training Phase 1 session: “Touch the screen (or picture) that matches.

Opportunity for breaks within the session: Would you like to take a break and play with a toy?

Opportunity to complete another block of trials after a break: Would you like to play the game again?

End of the Session: Thank you so much for playing the game. Which sticker would like?

APPENDIX B

Table 1

Summary of studies examining stimulus overselectivity

Author and Date	Population	Stimulus arrangements
Eimas (1969)	Normal children	Color-form patterns with 2-4 cues (color, form, size and border
Lovaas, Schreibman, et. Al. (1971)	Autistic, mentally retarded, and normal children	Simultaneous presentation of auditory, visual and tactile
Lovaas, Schreibman (1971)	Autistic children	Two stimulus presentation- visual/auditory
Koegel & Wilhelm (1973)	Autistic and normal children	Stimulus cards with 2 objects on each card
Wilhelm & Lovaas (1976)	Older mentally retarded children and normal children	Stimulus cards with 3 objects on each card
Schover & Newsome (1976)	Autistic and normal children	Single colored shapes on white index cards
Koegel & Schreibman (1977)	Autistic children	Simultaneous cues (visual & auditory) presented but no cues were redundant

Litrownik et al (1978)	Autistic, Downs syndrome and normal children	Combinations of two attributes across four dimensions (color, shapes, size, number of items)
Anderson & Rincover (1982).	Autistic and normal children	Dots on cards form shape of different sizes
Bickel, et al (1984)	Normal children	Auditory stimuli- continuous and discrete sounds
Bickel, Richmond, et al (1986)	Mentally retarded adults	Pairs of shapes presented; one shape per index card
Rincover, Feldman, Eason (1986)	Autistic and normal children	Stimuli on index cards with numbers located small, medium and large distances away from center shape
Rincover & Ducharme (1987)	Autistic and normal children	Shapes on cards- within stimulus features (red triangle) and extra stimulus features (red strip across top of card and white shape.
Stromer, et al (1993)	Mentally retarded adults	Computer touch screen; sample stimulus appeared in center, then four objects appeared in corner's of screen
Duarte & Baer (1997)	Normal children and adults	Face recognition on white cards with black background

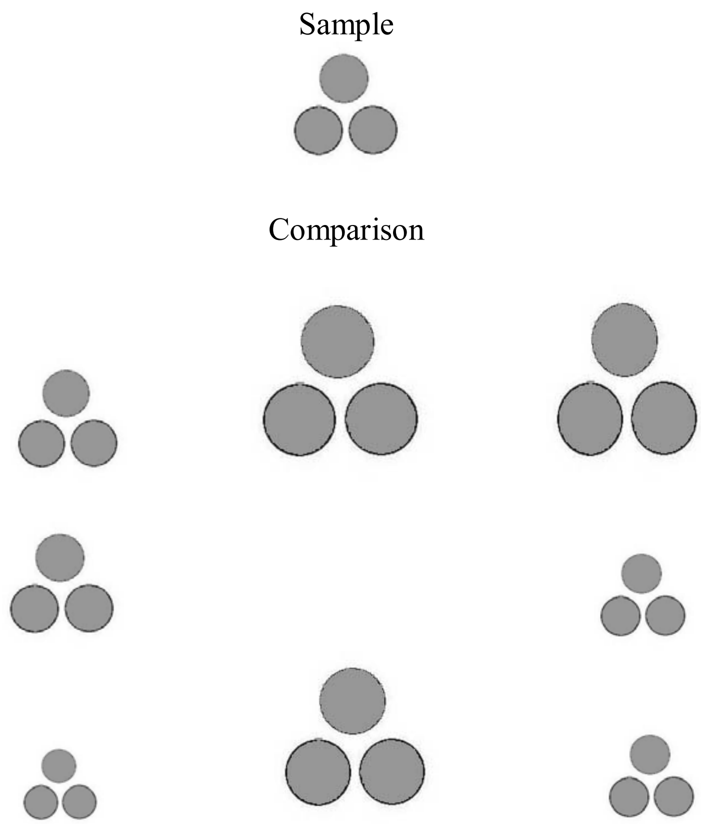

Figure 1. Size condition when stimuli were of low number and simple.

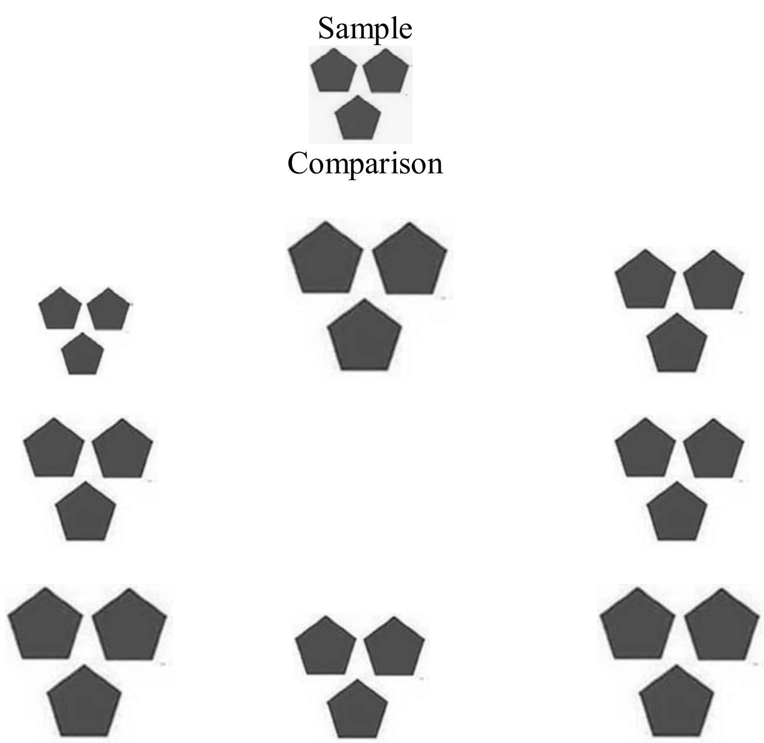

Figure 2. Size condition when stimuli were of low number and complex.

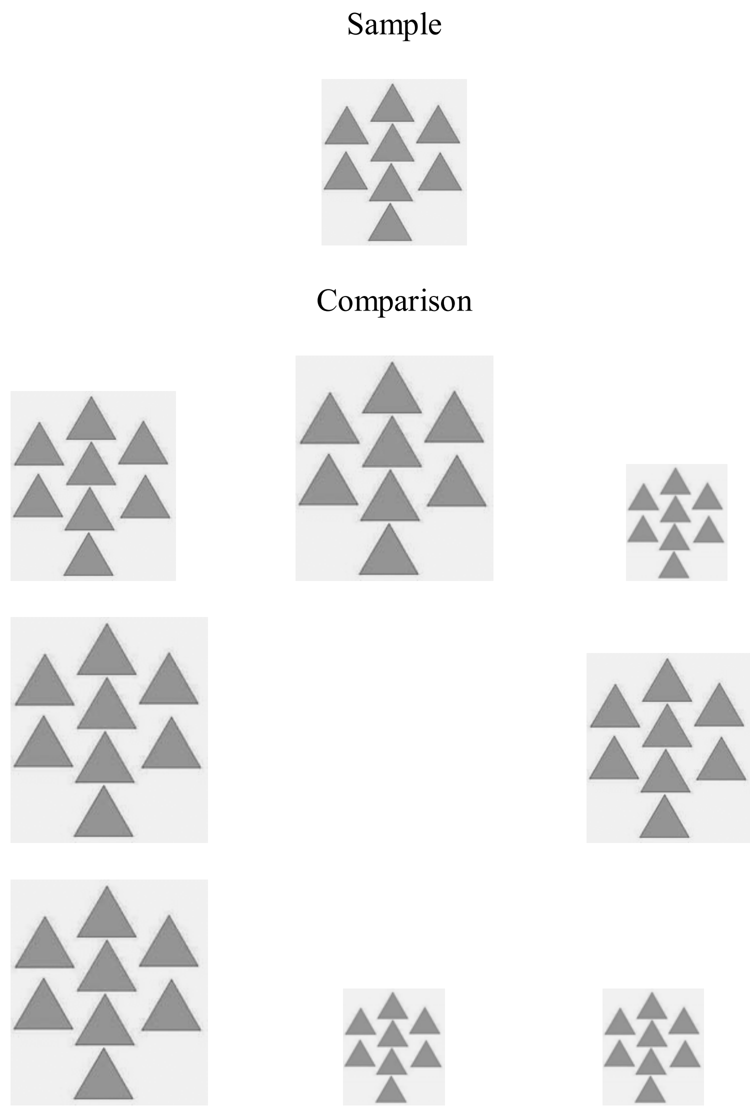

Figure 3. Size condition when stimuli were of high number and simple.

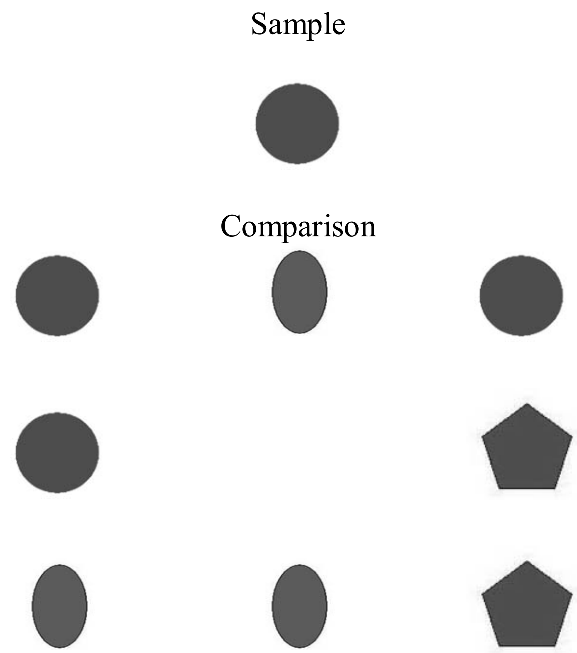

Figure 4. Shape condition when stimuli were of low number and small (or large) size.

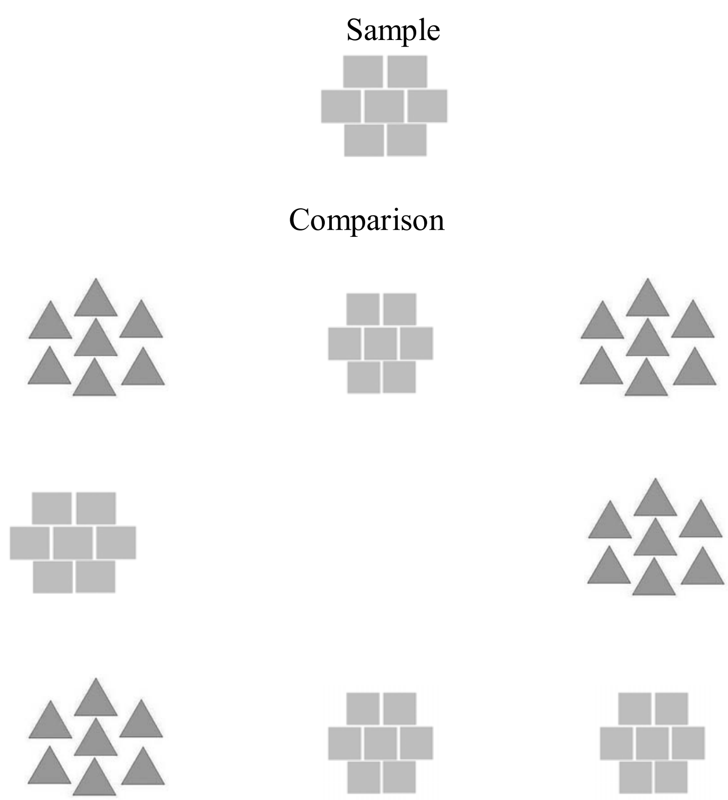

Figure 5. Shape condition when stimuli were of high number and small size (or large).

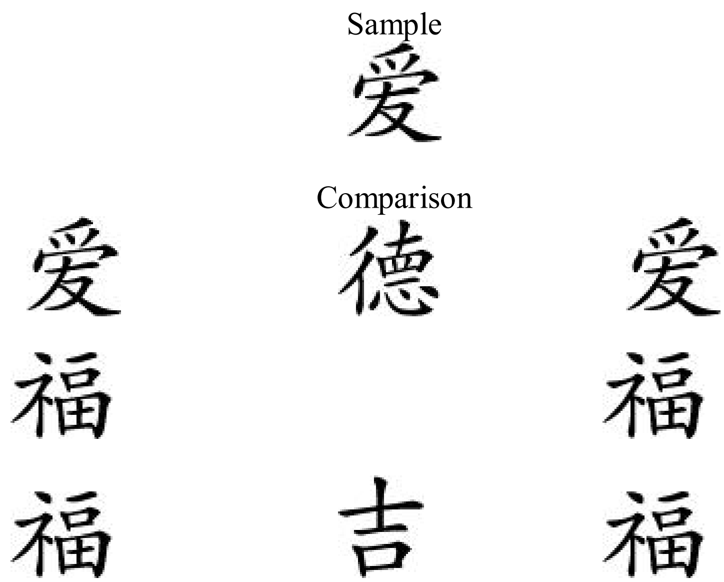

Figure 6. Shape condition when stimuli were Chinese Characters.

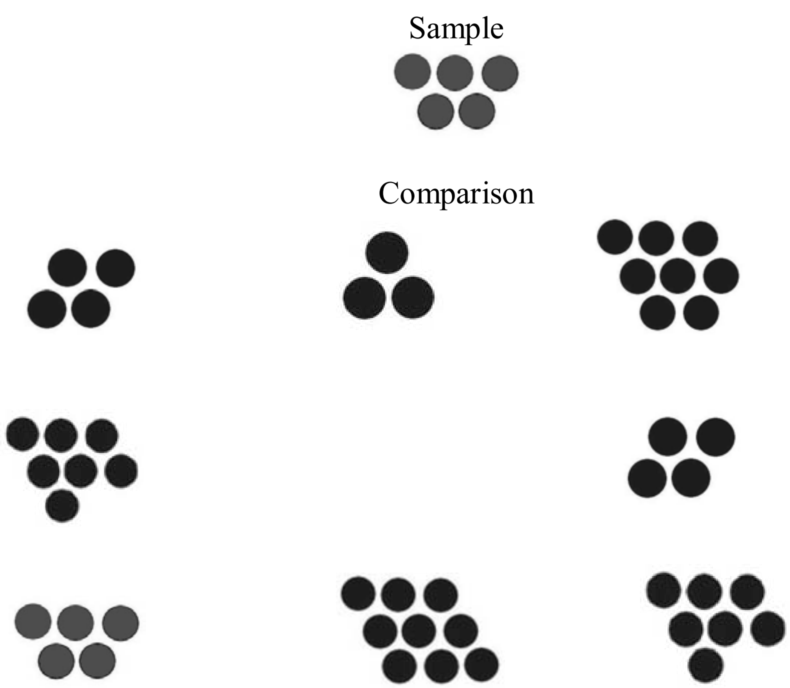

Figure 7. Number condition when stimuli were small (or large) and simple.

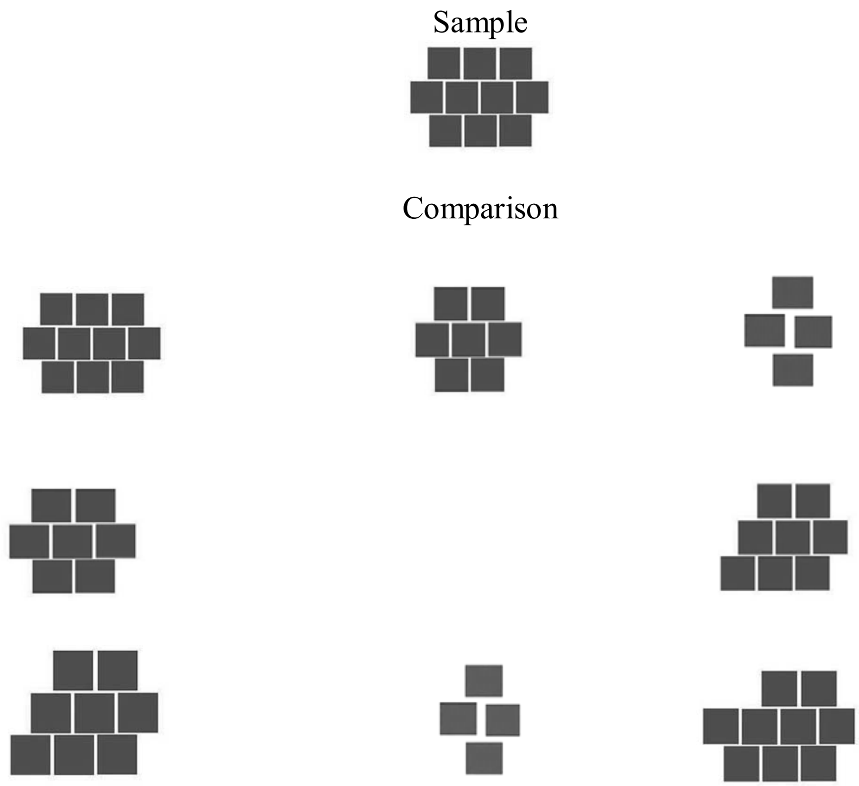

Figure 8. Number condition when stimuli were small (or large) and complex.

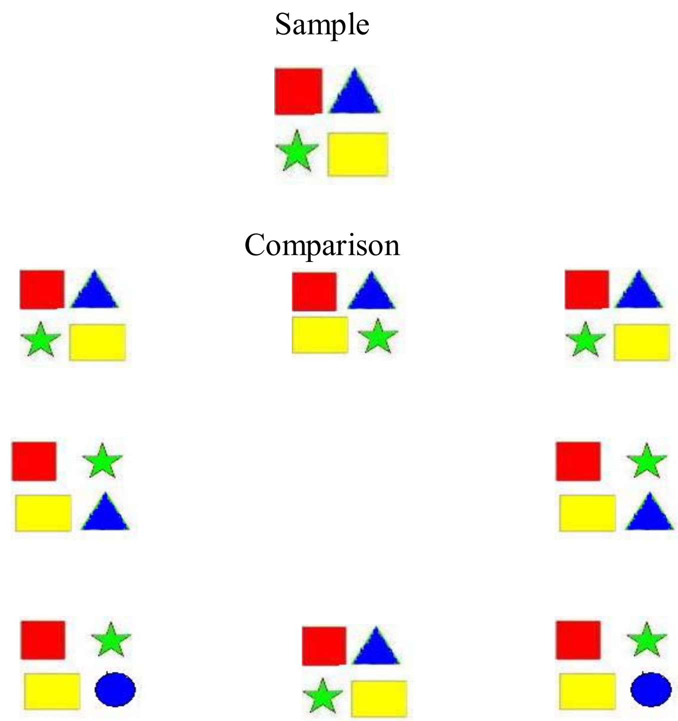

Figure 9- Configuration condition- no color cue. (Color nor shape of top left position differed)

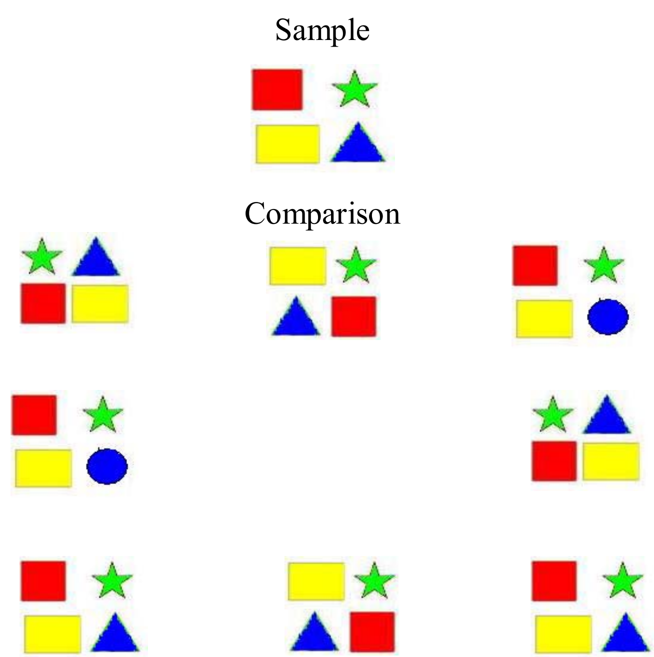

Figure 10- Configuration condition- color cue (Color and shape in top left position differed)

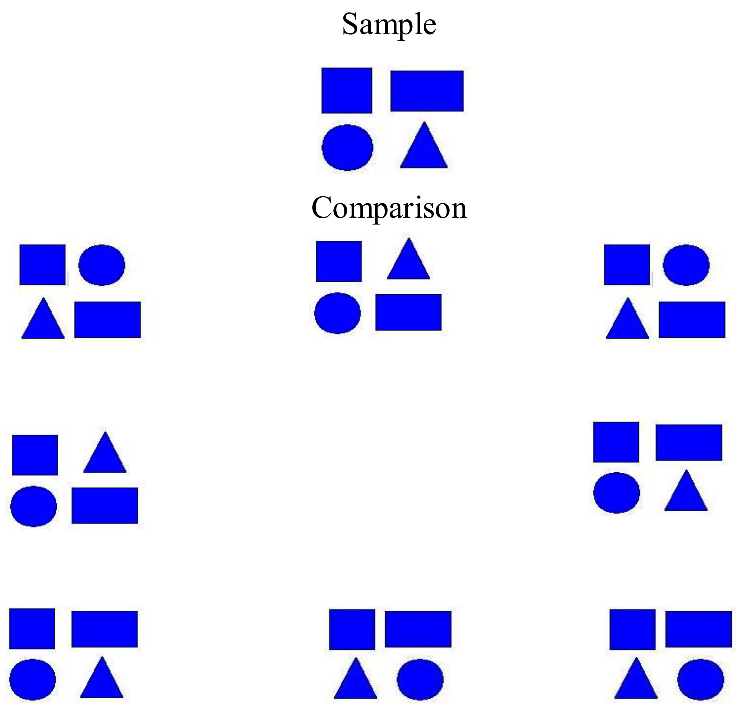

Figure 11- Configuration condition-same shape (Same shape remained in top left position)

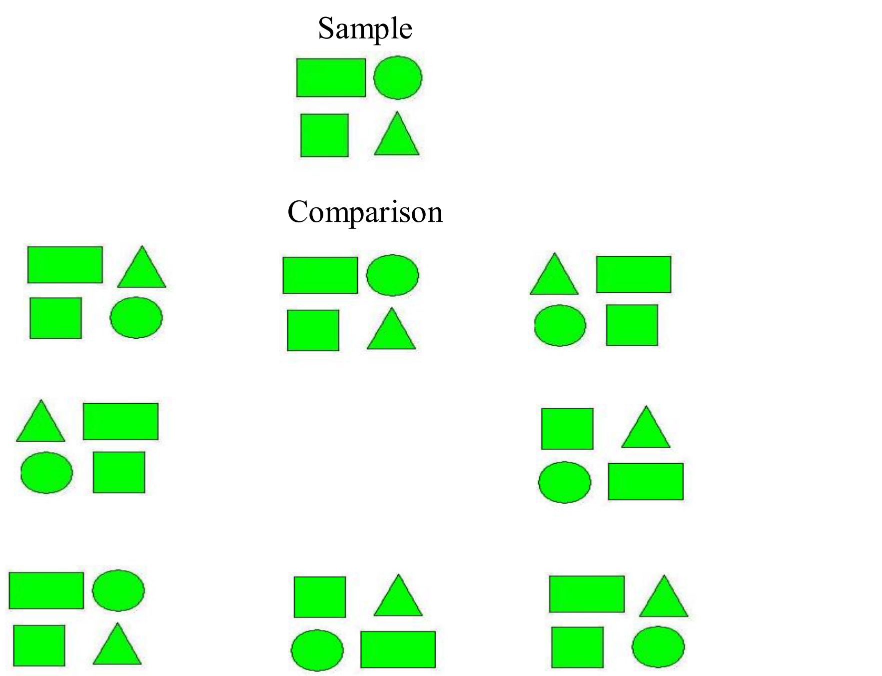

Figure 12- Configuration condition- different shape top left (Shape in top left position differed)

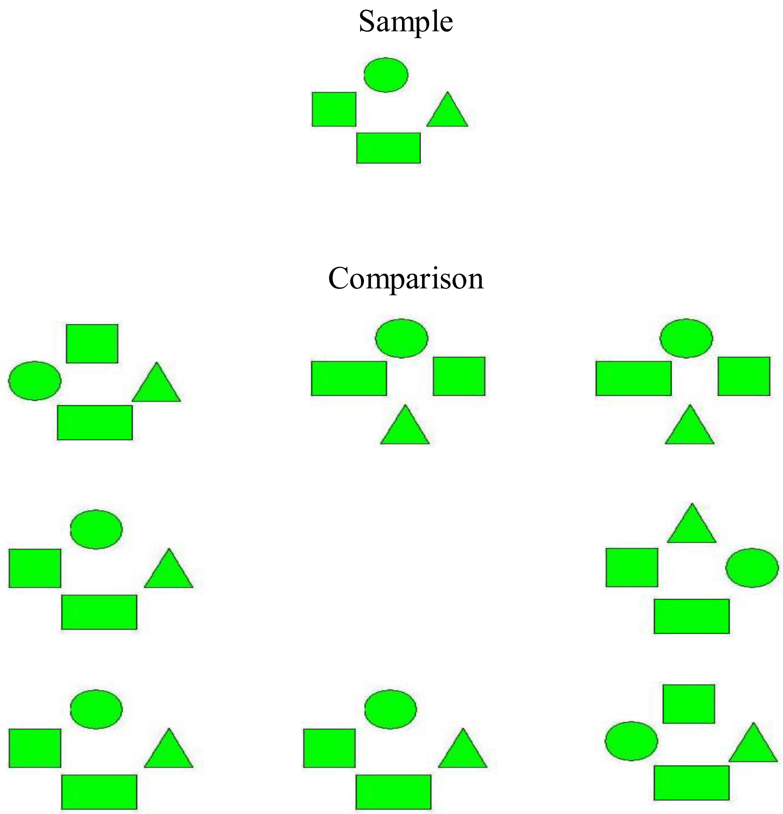

Figure 13-Configuration condition- Cross formation